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MORE SURPRISING PROPERTIES OF N-RAYS.

In addition to the other surprising properties of N-rays, it is now stated by well-known scientific men that N-rays—or, rather, those substances which have the property of emitting these rays—are affected by anæsthetics. A statement to this effect was made recently by Meyer, who found that plants subjected to chloroform lose their power of emitting N-rays. His work has been carried further by Becquerel, who has investigated the influence of anæsthetics on other sources of this surprising form of radiation. He found that several inorganic sources of N-rays lose temporarily their power under the action of chloroform, ether or nitrous oxide. These experiments raise the question, whether the emission of N-rays is a fundamental vital process. If so, where lies the dividing line between organic and inorganic bodies? In view of other investigations of a somewhat similar character, although along an entirely different line of research, this topic is becoming of increasing interest.

ELECTRIC LOCOMOTIVES FOR THE NEW YORK CENTRAL.

The electric locomotives built by the General Electric Company, Schenectady, N. Y., for the New York Central & Hudson River Railroad, and which were described recently in the ELECTRICAL REVIEW, are interesting from several points of view. In the first place, the motors of these large locomotives are two-pole machines, an apparent return to a primitive design, a type of construction which was adopted so as to allow of vertical movement of the armature between two horizontally placed poles. This requirement also made it necessary to use peculiar pole construction. The pole-face is not curved, but flat. Looked at in this way, the return to an early type is even more marked; but it is evident that the great advance which has been made in motor construction makes it possible to adopt this apparently less-efficient design, and yet, by discarding gearing and its consequent losses, to turn out a locomotive which the company believes is better than a geared motor construction. The electric motor is an efficient machine, and a case might easily arise in which a decrease in its efficiency, due to the use of an inferior design, might still give a more efficient result than would the use of the best design, when handicapped by gearing losses. How far this result has been accomplished in the design of these locomotives it will be interesting to learn. In general, the simpler the machine, the better.

Truck Forms Part of Magnetic Circuit.

In another respect, also, these motors are unique: the magnetic circuit does not consist of the usual separate box casting. The path of the flux is completed through the side and end-frames of the truck. Here we have a motor which forms an integral part of the locomotive, and which is not a separate piece of mechanism mounted on a truck.

Multiple Unit System of Control.

The method of control is one of the well-known multiple unit systems, which, in addition to other advantages, enables one or more of these locomotives to be coupled together at will. Thus, one standard unit only is required—that suitable for handling the average passenger train. For longer trains, and heavy freight trains, two or more of these locomotives may be coupled together and operated by one engineer. The multiple unit system of control may also solve the trailer problem. Trailers are, as a rule, abhorred by the operating street railway officer, but occasions do arise when they could be used with good results, did they not upset the running schedule by decreasing the running speed of the cars. But if the trailer is itself a motor car, and is merely coupled to the leading car and is controlled by the motorman on the latter, this trouble, to a large extent disappears.

THE WORLD'S FAIR.

The World's Fair at St. Louis is undoubtedly the largest and, from the electrician's point of view, the most instructive that has yet been held; but although the visitor will find there many opportunities for instruction, what he learns will depend largely upon his own efforts. We are apt to think of an exposition as a means to get wise easily. One thinks that if he can examine any machine or system in operation he will quickly learn all there is to know about it. This is not true. There is no royal road to learning, and an exposition of this kind only approaches such a road by bringing together many things of a widely varying character. In this way it reduces the effort which would be necessary to investigate each of these at its home, but in no way makes the work of understanding each lighter. A visitor to the fair will find that how much he profits by his trip will depend upon himself.

Variety of Exhibits.

At the fair practically every branch of electrical application is represented by a working exhibit, and where this has not been possible, models illustrating the method are shown. Many countries are taking part, though one could wish that they were more adequately represented in certain branches. France and Japan are the only countries which have dynamos on exhibition in the Palace of Electricity. In other branches, however, the foreign countries are well represented, notably in the construction of instruments and scientific apparatus, and in electric light appliances.

A Notable Power Equipment.

The electrical exhibits at the exposition are not confined to one building, but are to be found in the Palace of Machinery and the Palace of Transportation, as well as in the Palace of Electricity. In the former are gathered the large machines, which, in addition to being exhibits, form a working part of the exposition. In this respect the fair is notable, as the aggregate output is much greater than that of any previous exposition, being over 20,000 kilowatts. In the variety of electrical exhibits, this fair is also noteworthy and if it is not entirely successful, so far at least as the electrical features are concerned, it will not be because of a neglect to secure representation from every branch of electrical application.

ELECTRIC BRAKES.

From time to time one sees descriptions of very elaborate mechanical brakes designed to give perfect control of the unwinding of a rope or cable. Occasionally the machines to which these brakes are applied are, when winding in, driven by an electric motor. This combination suggests that, in such cases, and even in other cases where a smooth retarding force, variable at will, is desired, an electric or electromagnetic brake be adopted. Where a motor furnishes the driving force, it can easily be adapted to furnish also the retarding force.

Troubles of Mechanical Brakes.

A satisfactory mechanical brake is hard to realize. The retarding force is apt to be irregular, and the motion as the rope runs out more or less jerky. This can hardly be avoided, since the friction between two rubbing surfaces is a variable quantity, affected easily by slight changes in the conditions of operation. Moreover, the action of the brake itself causes wear which may tend to change the conditions and to affect the smoothness of operation. Then to conduct away the heat set free at the brake requires some elaborate cooling system.

Electric Brake Easily Controlled.

The electric brake, on the other hand, is under complete control at all times. The brake wheel can not jam, because the retarding force is due to the motion of the wheel. Then, again, there is no mechanical wear, and thus no uncertain and varying factor. The heat set free by the electric brake is easily handled, particularly when, for this purpose, a motor is being driven backward as a generator. The absorbing rheostat may be placed anywhere, and kept cool by circulating water. The only objection to an electric brake is that it does not hold when standing still, so that a mechanical brake for locking the apparatus, when not in motion, would be required in addition. This is really not a disadvantage, as, in nearly all cases, two brakes are required, and one of these would naturally be mechanical and could be operated automatically.

Other Advantages of the Electric Brake.

There are other minor advantages incident to the use of an electric brake which, at times, would be useful. Thus, it is easy to adjust the current-measuring instruments so as to indicate directly the torque exerted in pounds. The brake is more or less automatic, as it offers a greater retardation should the speed of unwinding increase for any reason. This renders running away practically impossible. Brakes of this type have met with great success on electric cars and in elevator service, and their use will doubtless increase when those in other lines of work appreciate the advantages of this type of apparatus.

CROSS-TIES.

In a recent publication of the Department of Agriculture, Washington, D. C., Mr. Herman von Schrenk makes a plea for a thorough trial of chemically treated ties. He anticipates unfavorable reports from those roads which do not make thorough trials, and which do not recognize the difference between such ties and untreated hardwood ties. The great advantage of the chemical treatment lies in the fact that it makes it possible to utilize soft wood; but the treatment can not prevent mechanical wear, which, on account of the softness of the wood and the increased life of the tie, is more pronounced unless proper mechanical protection is provided.

The problem of preserving forests, and yet meeting the increasing demand for ties, can best be solved, it seems, by adopting new tie forms. Ties of these types may be cut most advantageously from large logs, which produce two or more ties and, in addition, a number of boards. This will encourage the cutting of larger trees, and thus preserve the young growth. The form of these ties is discussed fully, as well as the means required to protect them against undue wear, by means of tie-plates and dowels. The monograph is a very valuable one, and will, no doubt, receive the attention which this important subject deserves. It is becoming more difficult each year for railroads to secure a sufficient supply of hardwood ties, and substitutes for wood have not found sufficient favor with railway engineers to promise any relief—at least, for many years to come.

Electricity at the Louisiana Purchase Exposition.

Some Features of the Great St. Louis Fair.

THE first impression of a visitor to the great fair now being held at St. Louis, Mo., is one of total inability to appreciate even a small part of what is there laid before him. The grounds are so large and the buildings so enormous, that the mere thought of inspecting them all is wearisome. And when it comes to the actual work of viewing the vast number of exhibits distributed throughout the 128 acres of buildings, he realizes how useless any effort upon his part will be. He is in somewhat the position of the man who, wishing for something pleasant and instructive to read, turns to an encyclopedia. He first reads one or two articles carefully, but he sees so many others before him, each presenting some claim for his attention, that he passes rapidly from one to another, reading a line or two here and another there, learning but little and soon becoming wearied by the number and diversity of the subjects before him. So it is in these great buildings. Wherever one turns there is always something to catch the eye and call for closer inspection. One or two exhibits possibly seem to need study, but the observer is so distracted by the many others waiting for him that ere long he finds himself wandering through the building, glancing here and there, seeing but little and remembering less, until he reaches a condition when nothing impresses him and all seems commonplace.

THE PALACE OF ELECTRICITY, NIGHT SCENE, WORLD'S FAIR, ST. LOUIS, MO.

This is true not only of the exposition as a whole, but also of each of the beautiful exposition palaces; and, indeed, the same fault might be found with some of the fine exhibits themselves, though possibly the fact that the observer's capacity is limited should not be called a fault of the exhibit. This is particularly true of the display in the Palace of Electricity and Machinery. Electrical energy is applied in so many ways, and for such diverse purposes, that the visitor is apt to come away with the idea that nothing is impossible to electricity.

To learn the lesson of the Louisiana Purchase Exposition, unless one has unlimited time at his disposal, one must devote himself to some one subject. In other words, he must specialize. If he is interested in electric lighting, he will find more than enough fully to occupy his time. He will be shown all the different systems of electric lighting, including several which he will see for the first time, together with ornamental electroliers and lighting fixtures which are indeed beautiful works of art. He will see in operation generators representing the highest development of dynamo construction, and will be given a practical demonstration of the effects produced by different shades and reflectors; and at night he will have an unequaled opportunity for studying the illumination of the buildings and grounds. Never before has there been such a lavish use of light, and possibly never before were so many beautiful and varied effects produced. No two of the palaces are alike, and this difference is brought out by the brilliant illumination as well by night as by day.

If the visitor is interested in any other branch of the electric arts, the effect is the same. Should his specialty be transportation, he will find presented for inspection all types and makes of motors, controlling apparatus, cars and car equipments. Should it be power transmission, he will be able to examine not only generators and motors, but all the auxiliary apparatus necessary for a successful system. The telephone engineer will see examples of the most perfect exchanges, both of the manual and automatic types. Telegraphy by wire and wireless, electric heating, electrotherapeutics, electrometallurgy, and, in fact, every branch of electrical application is here not only well represented, but, in practically all cases, shown in actual operation.

The one distinctive feature of the Palace of Electricity and Machinery—in fact, the keynote of the electrical exhibition—is operation. So far as has been possible, all the exhibits are working exhibits, and not mere displays of machines. It was thought that this plan would not only add greatly to the interest of the exhibits, but would prove far more instructive, since the visitor would not only be shown the machine, but as it would be at work, he could see what it would actually do. In this way not only would the specialist have demonstrated to him what others working along the same lines are doing, but those less familiar with the electric arts would be given some idea of the rapid strides which have been made in recent years.

Probably the best way to give an idea of the plan adopted and carried out, as far as possible, by Professor W. E. Goldsborough, chief of the department of electricity, would be to describe briefly a few typical exhibits. To describe or even to mention all would be impossible. Upon entering the building from the plaza of St. Louis, the first thing to catch the eye is the large enclosure containing the German exhibit. If the visitor has time, he will find here much of interest, but, unfortunately, this section of the German exhibit is given up mostly to education and chemistry. There is, however, an excellent collection of apparatus which bore an important part in the development of electrochemistry. While the greater part of this electrochemical exhibit is of more importance to the chemist than to the electrical engineer, the furnaces used by Borcher and the electrochemical apparatus of Nernst and Ostwald will detain him for a moment or two. The electrical apparatus exhibited by Germany has, for some reason or other, been placed in the Palaces of Education and Varied Industries.

Passing through this German section, one comes upon the fine exhibit made by

the General Electric Company, of Schenectady, N. Y. This contains electrical appliances erected so as to demonstrate the practical operation of each device. Railway motors and the new controlling systems, transformers of various types illustrating the several methods of cooling, high-tension apparatus, electric lamps and motors for machine driving are all there in operation. One of the striking features of this exhibit is an outer armature casing of the vertical internal field type of generator, developed for use with water and steam turbines. This has been erected on an imitation foundation, and thus forms a unique booth which is used as an office and for receiving visitors.

EXHIBIT OF THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY.

Across the hall from the General Electric Company are the Edison exhibits. Here are to be seen, in one section, the Edison storage battery and kinetoscope. Adjoining this are three booths which form the handsomely furnished headquarters of the National Electric Light Association, American Institute of Electrical Engineers and the Association of Edison Illuminating Companies. Adjoining the latter is the fine historical Edisonian exhibit. It contains some of the early Edison dynamos, among them being the celebrated "Jumbo" machines, and specimens of the first successful incandescent lamps.

Diagonally across the hall from this exhibit is located the Holophane Glass Company, New York city. This company has erected an exceedingly handsome booth, and has spared no expense in fitting it up. The inner room is furnished with hardwood panels, which were taken from a residence on Fifth avenue, New York city. The furniture is in keeping with the handsome walls, and upon the latter are hung a number of fine water-colors. From the paneled ceiling are hung various types of electroliers. This room serves not only for entertaining visitors, but to illustrate the different lighting effects which may be secured by using the Holophane globes and reflectors. The room can be divided by a central curtain, and each half may be illuminated independently of the other, thus making comparison of effects easy. At each end of this room are two demonstrating rooms fitted with darkened booths and shades, and within these are fixtures to which the different globes may be attached, and the effect attained at once shown. The roof of the booth has been fitted up as a roof garden where visitors will be entertained. On the outside, this booth has been fitted up with electric flashing signs, some of which show seven color effects. At the two ends of the booth are porticos, also brilliantly lighted by means of Holophane appliances.

East of the Holophane company, across the aisle, is the large section reserved for the National Bureau of Standards, Washington, D. C., which is entirely enclosed, and where the delicate scientific apparatus and standards of this bureau are being set up.

Very appropriately, in this section of the building is the exhibit of the Weston Electrical Instrument Company, of Waverly Park, Newark, N. J., which is just across the aisle from the National Bureau of Standards, and which faces the southeast entrance to the building. This is a large booth very handsomely fitted up, in which are displayed a large number of those celebrated instruments. Here will be found also some of the newer types recently brought out by Dr. Edward Weston.

In the block just west of this is the working exhibit of the Kellogg Switchboard and Supply Company, Chicago, Ill. This consists of a working exchange with a capacity of 3,500 subscribers, which is giving actual service to the officers of the exposition and the exhibitors. The switchboard panels are identical with those recently installed in the Cleveland exchange, and have a capacity for 19,000 subscribers. The capacity of these panels is much greater than that of any heretofore constructed, and it has only been made possible by skillful design and by reducing

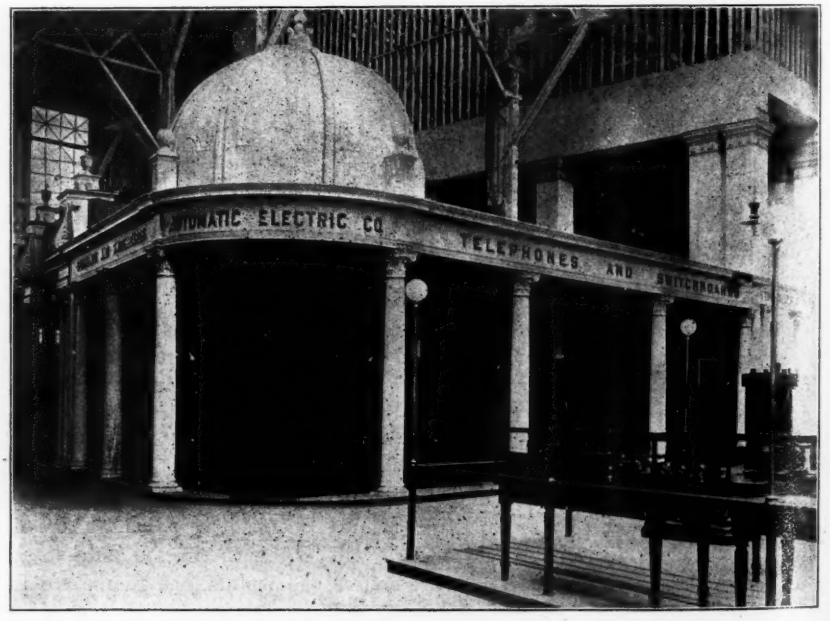


EXHIBIT OF THE AUTOMATIC ELECTRIC COMPANY.

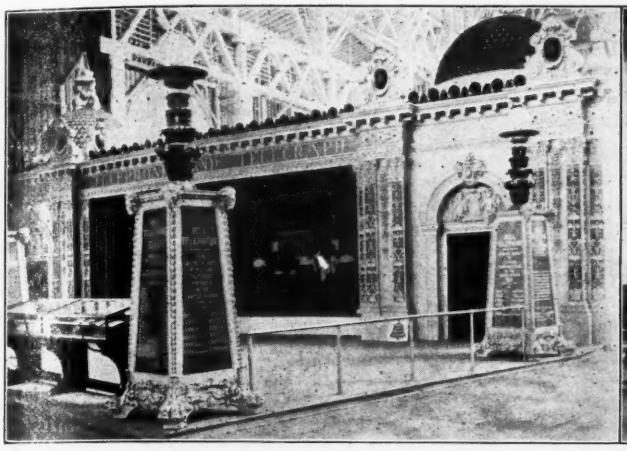
the size of all parts. The Kellogg company is also exhibiting here its new harmonic system for four-party wires. On a table beside the generator for the working exchange are two harmonic ringers, and a rack is set up, upon which are mounted several sets of apparatus adjusted to the different calling frequencies. In addition to the working switchboard, two other panels of the Cleveland type are shown, which enable the construction and arrangement of all the parts to be seen. The company has also a fine display of telephone appliances, and, in an adjoining section, has two machines in operation covering wire with silk.

Adjoining the Kellogg Switchboard and Supply Company's booth is the booth of the Automatic Electric Company, Chicago, Ill., where an automatic telephone exchange has been erected, which is giving actual service. Its capacity is only 100, but the apparatus is of the 10,000-subscriber type. The Strowger system, which is here shown in operation, attracts considerable attention, the arrangement being such that the visitor can watch the entire operation of sending and calling, and the action of the switches in making connections.

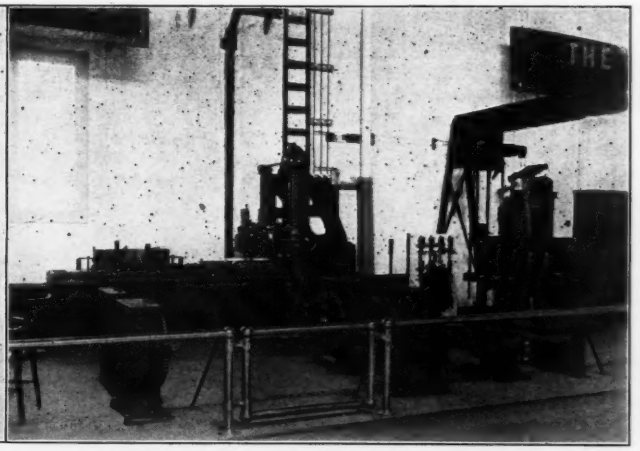
The American Telephone and Telegraph Company, Boston, Mass., has a working exchange located opposite the southwest entrance to the building. This exchange also is giving service to the building and grounds, and is a model of what a small exchange should be. The ultimate capacity of the panels is 9,000 subscribers. In addition to the working exchange, there is here shown a collection of historical telephone apparatus. Besides the above, the American Telephone and Telegraph Company is exhibiting the Ruhmer system of wireless telephony. Two searchlights are set up, one adjoining the booth and the other at the northern end of the hall, over 400 feet away. This latter is the transmitting station, the other being the receiving station. The system is in successful operation.

Another wireless telephone system is exhibited by Miller Reese Hutchinson, of New York city. Around the inner court of the Palace of Electricity a wire has been laid in the ground. This is connected to a booth within the building, where the person who is to send the message takes his position. By means of a portable receiver carried in the hand, one can move about within the court and hear distinctly whatever is being spoken into the transmitter.

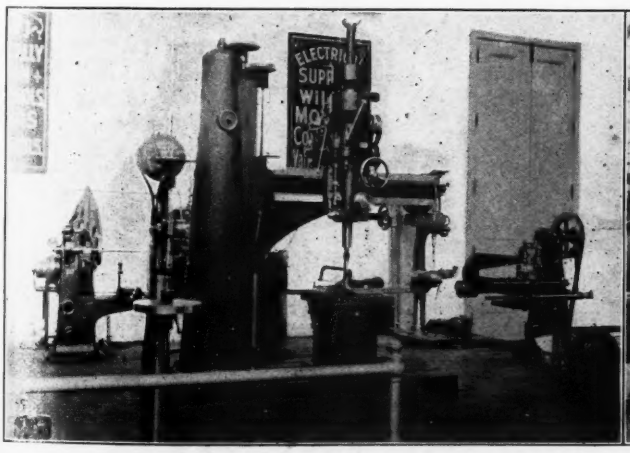
To the left of the south entrance, as one enters the building, is the excellent exhibit of the Electric Storage Battery Company, Philadelphia, Pa. This consists of a model fireproof and acidproof battery house, in which is a railroad battery of chloride accumulators. This battery is controlled by a booster set, and is used to regulate the voltage of the system in the building. Standard battery and booster switchboard panels are in place, and standard combined power and light panels and feeder panels are also shown. There is, in addition, a 100-kilowatt General Electric booster, and electrically operated and electrically controlled end-cell



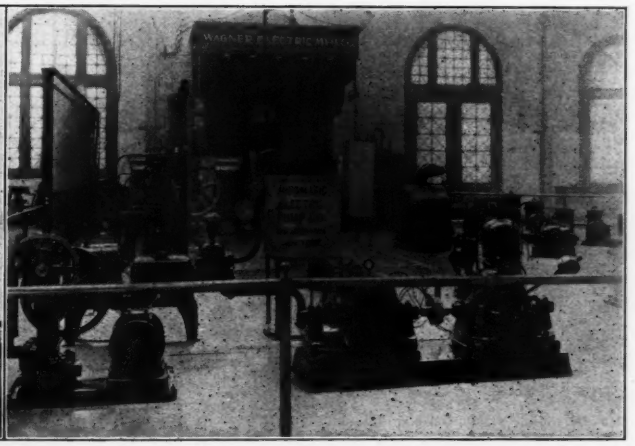
THE OPERATING TELEPHONE EXCHANGE, EXHIBITED BY THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY.



CONTROLLERS FOR ELECTRIC CRANES AND MOTOR-DRIVEN MACHINE TOOLS. THE ELECTRIC CONTROLLER AND SUPPLY COMPANY.

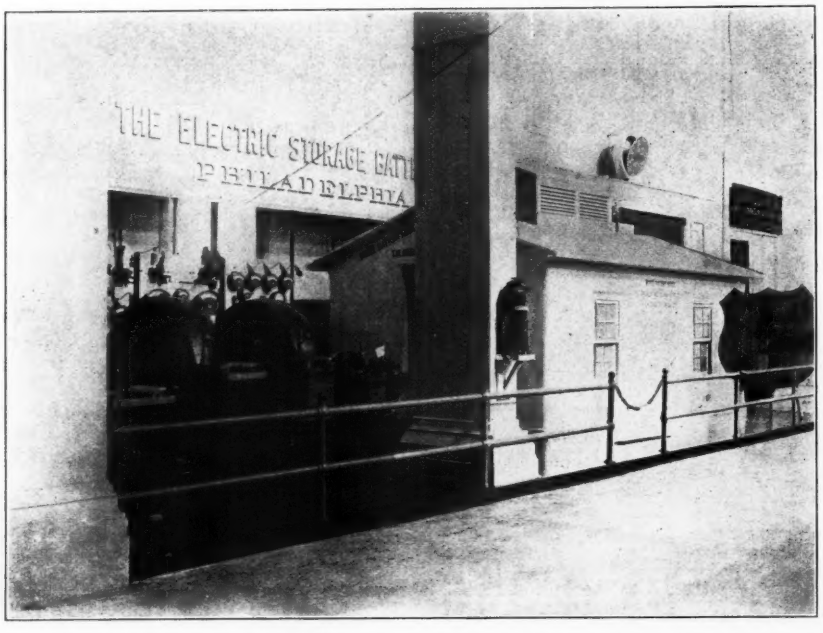


ELECTRICALLY-DRIVEN MACHINE TOOLS, EXHIBITED BY J. CLARK, JR., & COMPANY.



THE WAGNER EXHIBIT AT THE WORLD'S FAIR, SHOWING APPLICATIONS OF THE SINGLE-PHASE INDUCTION MOTORS.

switches for the Edison three-wire system, with the corresponding switchboard panels. Various types of battery are on exhibition, as well as the different types of plate. A striking feature of this exhibit—to many, at least—is the large map, thirty by forty-five feet, which is hung on the wall. This is illuminated from behind, and is dotted with jewels, each indicating by its position and color a battery installation of a particular type which has been made by this company.

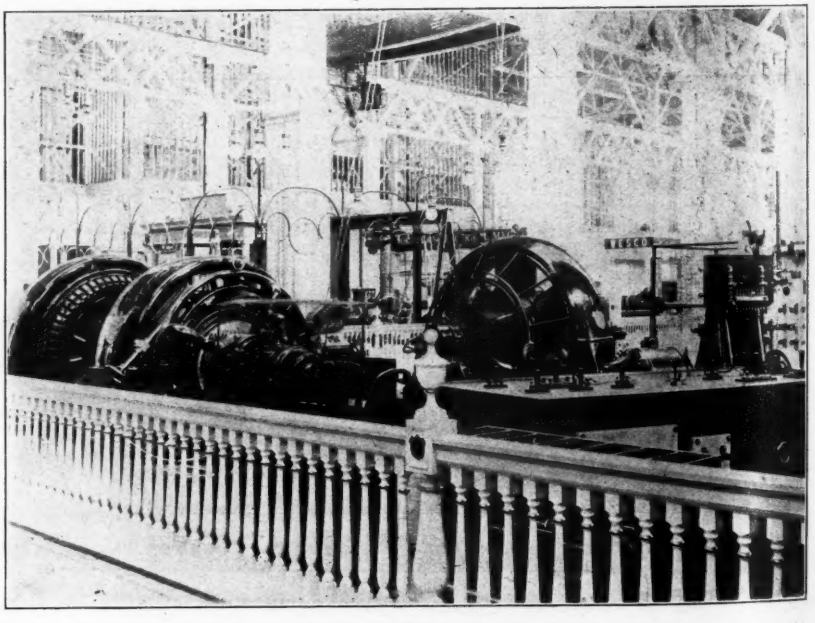


THE ELECTRIC STORAGE BATTERY COMPANY, BATTERY HOUSE AND AUXILIARY APPARATUS.

The Gould Storage Battery Company, New York city, is making a fine display. Its booth is along the west wall of the building, just south of the west entrance. The exhibit consists of various types of Gould cell, some of these having a very large capacity. The large battery exhibited at Buffalo is again shown here. There are shown, also, the various types of Gould plates, switchboards, boosters and charging sets. An interesting piece of apparatus here is the twelve-horse-power four-volt "unipolar" generator, which is driven by a twelve-horse-power direct-current motor. This is used to charge a battery consisting of two cells, each of fifty-one plates of the U-type, having a capacity of 5,600 ampere-hours. After charging, this equipment will be used in the reverse order, the batteries discharging through the "unipolar" generator, thus driving the motor as a generator, which will return power to the line.

All of the well-known firms which build motors and generators make a good showing of their apparatus. The Western Electric Company, Chicago, Ill., is exhibiting its arc-light system and generators and motors for all purposes. The National Electric Company, Milwaukee, Wis.; the Warren Electric Manufacturing Company, Sandusky, Ohio; the Northern Electrical Manufacturing Company, Madison, Wis.; the Fort Wayne Electric Works, Fort Wayne, Ind., and the Commercial Electric Company, Indianapolis, Ind., all show their machinery at work.

In the west part of the building, in the blocks adjoining the court, are found two very interesting exhibits. The Bullock Electric Manufacturing Company, Cincinnati, Ohio, shows a line of its direct-current motors operating automatically, the smallest starting up first, being followed successively by the others, until the largest comes up to full speed. This cuts out the smallest, which in turn cuts off the next, and so on until the whole line has been brought to a standstill, when the process begins again. This not only illustrates the action of the automatic controllers, but serves to attract considerable attention to this section. This company is showing also balancers for its multi-voltage system, street railway motors and controllers, and a pair of direct-current generators driven by a De Laval steam turbine. It shows also a number of motors driving machine tools, one of these acting through a mechanical device for varying the speed. To the electrical engineer the best part of this exhibit consists of the testing table and the machines associated with it. This is the standard table used in the Bullock company's testroom, and is here in actual use, showing the Hopkinson circulating test and the Behrend method for testing alternators. In this section of the exhibit there is a 500-kilowatt rotary with a switchboard and transformer equipment. Another interesting feature of this exhibit is an alternating-current generator illustrating the different stages of construction. It shows how the armature segments are put together, the coils laid in place, the field-poles assembled and attached to the hub, and how the field coil is wound and held in position.



THE BULLOCK ELECTRIC MANUFACTURING COMPANY, GENERATORS, ROTARY CONVERTERS AND APPLIANCES.

Adjoining this exhibit is that of the Wagner Electric Manufacturing Company, St. Louis, Mo. The purpose of this exhibit is to demonstrate the applicability of the single-phase motor for general

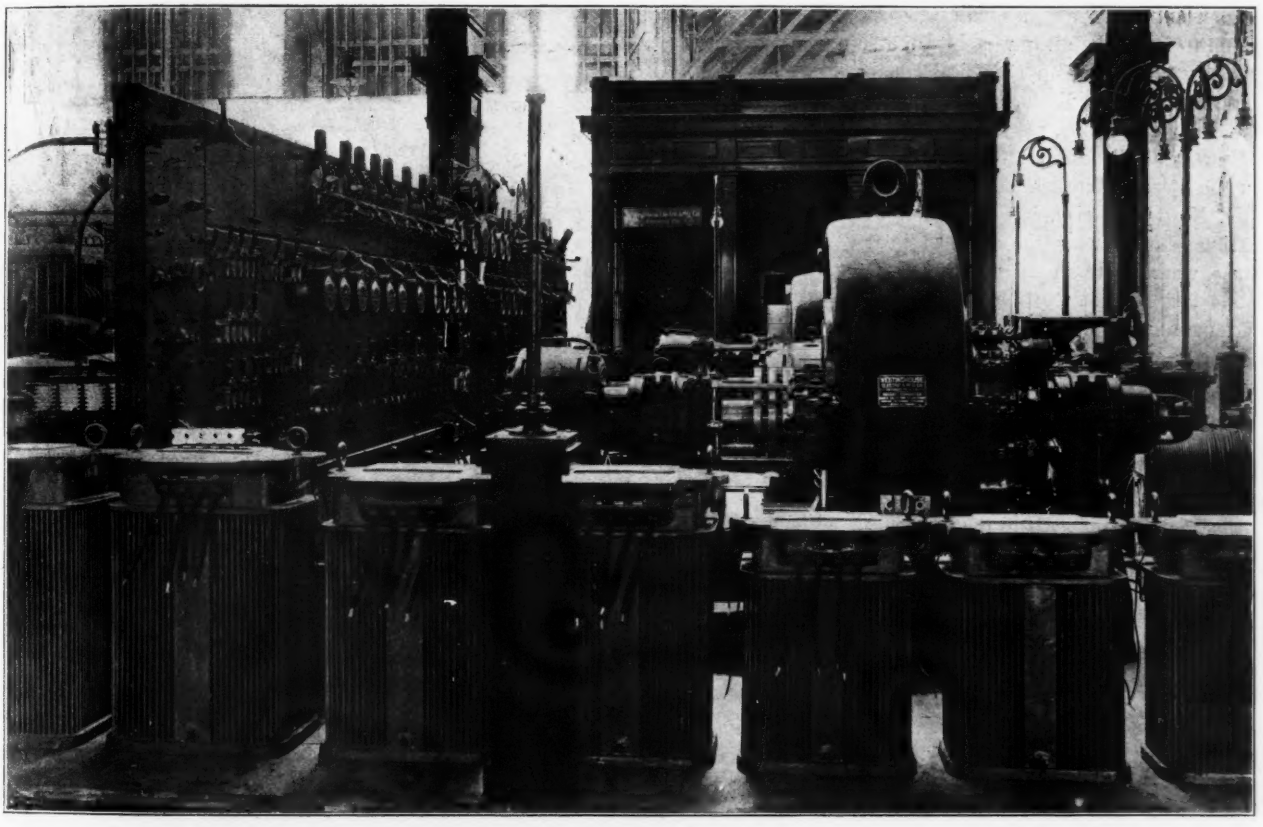
power purposes. This motor is shown driving machine tools, organ blowers, dough machines and ventilating fans. The speed of the machine tools is varied—giving changes from eight to one—by means of the controller. There are also shown motor-generator sets, a direct-current generator being driven by the single-phase motor. The application of this motor to house pumps is demonstrated by its differing equipments. The action of the motor is controlled automatically by the height of the water in the tank. This merely opens or closes the switch, the cutting out of the starting devices being controlled by the motor itself. The company shows a full line of its well-known transformers, of the air-cooled, self-cooled and water-cooled types. There is, too, a five-panel switchboard, equipped with high-tension switches and instruments.

The largest exhibit in this part of the Palace of Electricity is that of the Westinghouse Companies. This is located in the northwestern part of the building, and, together with the exhibit of the Baldwin Locomotive Works, occupies portions of three large blocks. The Baldwin-Westinghouse exhibit is opposite the northwest entrance. Here there are two mining locomotives, and a switching locomotive is shown running backward and forward on a short track. Across the hall from this are two large sections containing the main Westinghouse exhibit where are shown typical generators for direct and alternating currents, motor-generators, transformers of various types, direct and alternating-current railway motors and controllers, induction motors, variable-speed motors, both for direct and alternating currents, switchboard apparatus and instruments, regulators and electric railway systems. The Westinghouse Companies are showing here the various types of electric lamps which are controlled by the Westinghouse interests.

Adjoining the Westinghouse-Baldwin exhibit is a very interesting exhibit made by the Standard Underground Cable Company, of Pittsburg, Pa., and the McRoy Clay Works, Brazil, Ind. This consists of two brick manholes of standard construction, connected by McRoy conduits. Through several of the ducts cables have been drawn and are laid in place on the manhole racks. One large cable is shown in the process of being drawn in. The arrangement is such that visitors can descend into the ditch and examine the exhibit.

In addition to the exhibits of machine tool driving already mentioned, there are several others which deserve mention. The Electric Controller and Supply Company, of Cleveland, Ohio, located at the west side of the building, near the northwest entrance, is showing controllers for motor-driven machines and cranes. These are automatic, and it is only necessary for the attendant to throw the handle one way or the other, the starting resistance being cut out automatically as the motor comes up to speed. The most striking part of this exhibit is the large Niles-Bement-Pond planer, driven by a fifteen-horse-power Westinghouse direct-current motor, and governed by one of these controllers, which automatically starts, stops and reverses the motor. The company shows also a small electric crane with a lifting magnet for handling bars and plates of iron.

The exhibit of James Clark, Jr., & Company, of Louisville, Ky., which is on the south side of the building, near the southwest entrance, consists of electrically operated machine tools. The feature of these tools is the method of attaching the motor, this, in fact, being really a part of the tool itself, as the frame of the motor is cast solid with that of the tool. This company is showing planers, shapers, punches, drill presses, grinders and other tools at work making motor parts. The method of controlling these motors al-



A Corner of the Westinghouse Exhibit in the Palace of Electricity, World's Fair, St. Louis.

lows the speed to be varied, the large drill press shown having nine motor speeds, and, with the back gear, nine more, making eighteen in all.

Among the other interesting exhibits in this building is that of the United States Incandescent Lamp Company, St. Louis, Mo., where incandescent lamps are being made.

The Postal Telegraph-Cable Company and the Western Union Telegraph Company have model telegraph offices. The Automatic Fire Alarm Company, New York city, shows its various systems of hand and automatic fire-alarm instruments. The National Cash Register Company, Dayton, Ohio, shows its electric cash register system, which indicates the amount of a sale at any point of the building. The American Electrical Heater Company, Detroit, Mich., has a fine display of electric stoves, ranges and heating appliances of all descriptions. The American De Forest Wireless Telegraph Company, New York city, has a large transmitting station near the southwest entrance, where there are three towers seventy-five feet high supporting the antennæ. Here messages are sent and received from a number of stations located about the grounds, one being on the observatory tower, and one in the Government Building. There is also one a short distance along the aisle in the Palace of Electricity, which, when acting with the transmitting station, demonstrates easily the method of sending and receiving.

Besides the German exhibit, France has reserved a large space adjoining the German section, where many French houses are showing machinery and appliances. Here is seen a model of a cable-making plant. In one corner is a historical exhibit, where the original dynamo may be seen. Electric lamps and carbons are shown, and some exceedingly beautiful electroliers, electrical supplies and batteries, meters, both of the indicating and recording types, and samples of ocean cables. The administration of postage, telegraph and telephone shows a number of telegraph equipments. The Société Gramme, Paris, is exhibiting transformers and motors, among the latter being a variable speed machine, the variation being accomplished by a lateral movement of a number of iron cores inserted through openings in the pole-piece. The Société Alsacienne de Constructions Mecaniques, Belfort, shows a large three-phase induction regulator.

The exhibit of the English companies is on the left as one enters from the north or main entrance. The most noticeable exhibit here is a model of the Behr mono-rail system. The rest of the exhibit consists mainly of electrical and scientific measuring instruments and telephone and telegraph apparatus. Among the interesting scientific appliances are six Crookes spinthariscopes, showing the scintillations of radium. Elliott Brothers, Lewisham, London, have a fine display of portable voltmeters and ammeters. Everett, Edgcumbe & Company, London, show insulation indicators, two-phase and three-phase power-factor indicators and rotary synchronizers. Nalder Brothers & Company, Queen Anne's Gates, London, have some fine examples of standard apparatus.

Robert W. Paul, London, among other instruments shows a horizontal moving coil galvanometer. The coil is circular, surrounding a spherical core, the pivot of the coil having its bearing at the centre of the core, so that the instrument is practically independent of leveling.

Sherard Cowper-Coles & Company, London, show examples of a new process for coating metallic objects with zinc, which is known as sherardizing. This consists of placing the article to be coated in a receptacle in contact with finely divided zinc and kept at a comparatively low temperature, and the result is a uniform, smooth zinc covering, which, it is said, does not add to the thickness of the metal nor affect its physical state.

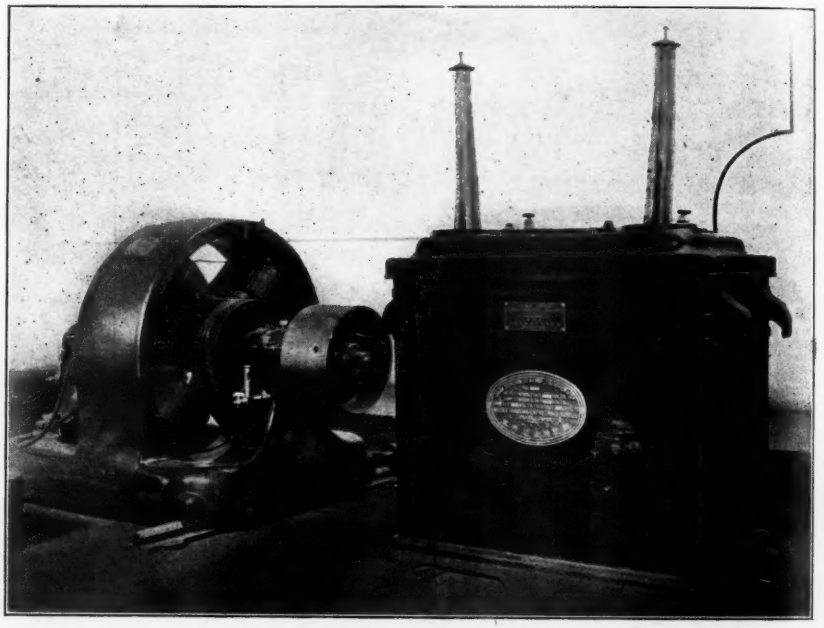
This company is also showing samples of electrically deposited parabolic reflectors and tubes, and sheets manufactured by the centrifugal process.

Italy has a section on the southern side of the building, where telephone and telegraph apparatus, indicating and recording instruments, lightning arresters and other appurtenances are shown.

Japan, in a section near the southwest corner, shows a 100,000-volt testing transformer and a direct-current generator, telegraph, telephone and electrotherapeutic appliances, and a number of charts and large photographs illustrating the power developments now going on in Japan.

Other foreign countries exhibiting in this building are Argentine, Brazil, Denmark, Mexico, Portugal and Spain.

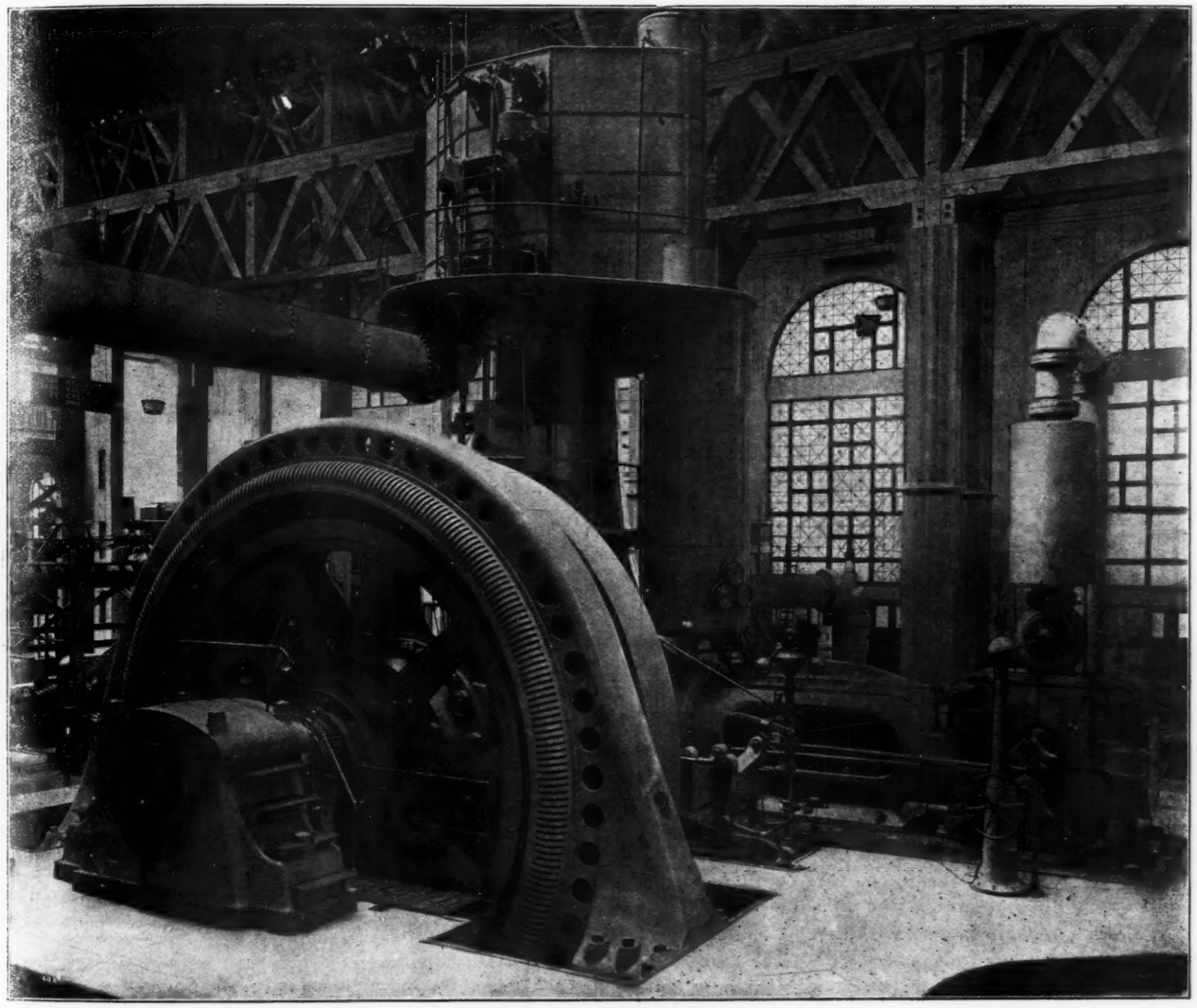
In the court of the Palace of Electricity and Machinery is laid a mine railway, upon which is operating a storage battery locomotive, exhibited by the C. W. Hunt Company, West New Brighton, Staten Island, N. Y. Here will also be found sections of electrical conduits of various types, constructed by the H. B. Camp Company, Chicago, Ill., and G. M. Gest, Cincinnati, Ohio, and an electric water-purifying apparatus built by the Electric Water Purifier Company, of St. Louis, Mo.



HIGH-TENSION TRANSFORMER AND DIRECT-CURRENT GENERATOR IN THE JAPANESE EXHIBIT.

The Palace of Machinery is directly west of the Palace of Electricity and Machinery, being separated from the latter by one of the lagoons. This building contains a great deal of interest for the electrical engineer. Entering it from the Palace of Electricity, one sees first some fine exhibits of machinery. Passing through these toward the power station, which is in the rear of the building, the first object to attract the attention is the fine generating unit in the Allis-Chalmers-Bullock exhibit. This is a large

Reynolds combined vertical and horizontal compound condensing engine, direct-connected to a three-phase Bullock alternator. The engine is rated at 5,000 horse-power, the cylinders being forty-four and ninety-four inches by sixty inches. The speed is seventy-five revolutions per minute, at a steam pressure of 150 pounds. This engine is of the type adopted for the Interborough Rapid Transit Company's power-house in New York city, except that the low-pressure cylinder is six inches larger.



THE ALLIS-CHALMERS-BULLOCK EXHIBIT IN THE PALACE OF MACHINERY, WORLD'S FAIR. A 3,500-KILOWATT GENERATOR DIRECT-CONNECTED TO A 5,000-HORSE-POWER ENGINE.

The flywheel of this engine is twenty-five feet in diameter and weighs 300,000 pounds. The length of the engine over-all is thirty-nine feet, and the height above the top of the foundation is thirty-nine feet two inches. This engine is operating with a barometric condenser made by the Alberger Condenser Company, New York city. The Bullock generator, which is connected directly to this engine, is rated at 3,500 kilowatts. It is a three-phase machine, generating at 6,600 volts, twenty-five cycles. It has forty poles, and the overload capacity is thirty-three and one-third per cent for five hours. The winding is laid in 240 slots, there being two coils per phase per pole. The machine will give, if desired, 10,000 volts. The guaranteed regulation is eight and one-half per cent with unity power-factor, and seventeen per cent with a power-factor of eighty-five. The temperature rise, after running for twenty-four hours on full load, is thirty-five degrees centigrade.

Passing beyond this unit, there will be found a number of fine equipments. The Crocker-Wheeler Company, Ampere, N. J., has a 900-kilowatt 550-volt generator, running at 100 revolutions per minute, and directly connected to a cross-compound Buckeye engine. There are also two 500-kilowatt, 500-volt generators running at 135 revolutions, driven by two Brown vertical compound Corliss engines, made by the Brown Corliss Engine Company, Corliss, Wis. The National Electric Company, Milwaukee, Wis., has a 6,600-volt, three-phase, twenty-five-cycle alternator, running at eighty-five revolutions per minute, being driven by a vertical compound engine, built by the Hooven, Owens, Rentschler Company, Hamilton, Ohio.

The Warren Electric Manufacturing Company, Sandusky, Ohio, has a 150-kilowatt inductor alternator, giving 220 volts, running at 212 revolutions per minute, and being driven by an engine made by the Skinner Engine Company, Erie, Pa. The Stanley Electric Manufacturing Company, Pittsfield, Mass., has a 600-kilowatt two-phase inductor alternator giving 2,400 volts, running at 277 revolutions per minute, being driven by a Willans engine, the latter built by the Bradley Manufacturing Company, Pitts-

burg, Pa. The Stanley company also shows a 132-kilowatt, 2,400-volt, two-phase generator driven at 225 revolutions per minute by a tandem compound engine furnished by the Buffalo Forge Company, Buffalo, N. Y.

All of these machines are being operated, each being called upon to do its work in running the motors and lighting the lamps throughout the grounds. However, they do not constitute the main service plant. This consists of four magnificent units, each being a 2,000-kilowatt generator directly driven by vertical compound engines. The engines were built by the Westinghouse Machine Company, Pittsburg, Pa., and were installed by Westinghouse, Church, Kerr & Company, New York city. The two outside engines drive Westinghouse three-phase generators at eighty-three revolutions per minute, giving 6,600 volts, twenty-five cycles. The inner two drive General Electric generators of the same output and type. In the rear of these units are found the exciting sets, and above the main operating switchboard. Over them are the ways for three traveling cranes, one furnished by the Shaw Electric Crane Company, Muskegon, Mich., which has a capacity of 120,000 pounds; one by the Niles-Bement-Pond Company, New York city, and one by the Pawling & Harnischfeger Company, Milwaukee, Wis., the latter company having also a fifty-ton crane in the Palace of Electricity.

The Westinghouse Companies show here also the Parsons turbine and the Westinghouse gas engine. The General Electric Company is showing the Curtis turbine. In fact, one can see in this building all the principal makes of gas and oil engines. Among those which may be mentioned are those of the Otto Gas Engine Works, Philadelphia, Pa., and Fairbanks, Morse & Company, Chicago, Ill. The American Diesel Engine Company has installed three 300-horse-power Diesel engines in the plant which furnishes light and power to the Tyrolean Alps, one of the principal attractions on the Pike. One will also see celebrated European engines, some of them driving generators of European make; one being a 700-kilowatt, fifty-cycle alternator of the revolving-field type built by the Société Alsacienne de Constructions Mecaniques, Belfort, France, directly driven by a tandem compound horizontal engine constructed by the Societe Elsaessische Maschinenbau Gesellschaft, Muelhausen, Germany.

In addition to the exhibits in these two buildings, there are other points which the electrical engineer should not fail to visit. One of these is the pump house under the cascades, where there are three large centrifugal pumps, each driven by a 2,000-horse-power Westinghouse induction motor. The whole equipment is designed to supply 90,000 gallons of water per minute for the cascades.

One feature which will be appreciated is the provision which has been made by some of the exhibiting companies for the comfort and entertainment of their visitors. The Allis-Chalmers Company has provided in Machinery Hall, adjoining its exhibit, chairs and tables for the use of its visitors, and has here telephone, telegraph and messenger service. There is also a specially fitted-up room for ladies. The Westinghouse company has, too, in this building, every facility for comfort and enjoyment of its callers.

A visitor to the fair will find also on the already famous Pike a number of shows which are well worth visiting. Here electric lighting and electrical phenomena have been made use of to a greater extent than ever before, and some of the storm scenes represented in Creation and the Galveston flood are very realistic and beautiful.

PANORAMA OF THE CASCADES, NIGHT SCENE, WORLD'S FAIR, ST. LOUIS, MO.

Worcester Polytechnic Institute.

The commencement exercises of the Worcester Polytechnic Institute was held during the week commencing Sunday, June 5. At 7.30 P. M. Sunday the baccalaureate sermon was preached by the Rev. Andrew Burns Chalmers, in Plymouth Church, Pearl and Chestnut streets, Worcester. Monday, June 6, 11 A. M., the entrance examinations began in Boynton Hall, Tuesday, June 7, at 8 P. M., the annual commencement lecture was given in the electrical engineering lecture rooms, Salisbury laboratories, by Mr. Arthur W. French, professor of civil engineering at the Worcester Polytechnic Institute. The subject of the address was "Skyscrapers." Wednesday, June 8, 8 to 10 P. M., the president's reception to the alumni and senior class. Thursday, June 9, 10.30 A. M., graduating exercises in the assembly room, Boynton Hall. The commencement address was delivered by Dr. Ira Remsen, president of Johns Hopkins University. At 1 P. M., the alumni dinner was held at the institute, followed by the annual meeting of the Alumni Association. The buildings and laboratories of the institute, including the dormitory at Newton Hall, was open for inspection on commencement day.

An Electric Furnace.

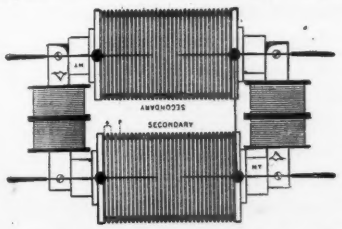
Dr. Harmon V. Morse, of Johns Hopkins University, Baltimore, Md., has devised an ingenious electric furnance for use in the chemical laboratory. The furnace consists of a copper oven, doubly lined with asbestos, and with an air space between the linings. Without, the furnace is painted with aluminum paint, which is not only a poor radiator, but is unaffected by high temperatures. The heater, which is placed within the oven, is formed of a number of parallel slabs of soapstone, each coated with graphite. The graphite forms the conducting resistance, and the soapstone insulating slabs are unaffected by the high temperature.

NOTES ON X-LIGHT.

BY WILLIAM ROLLINS.

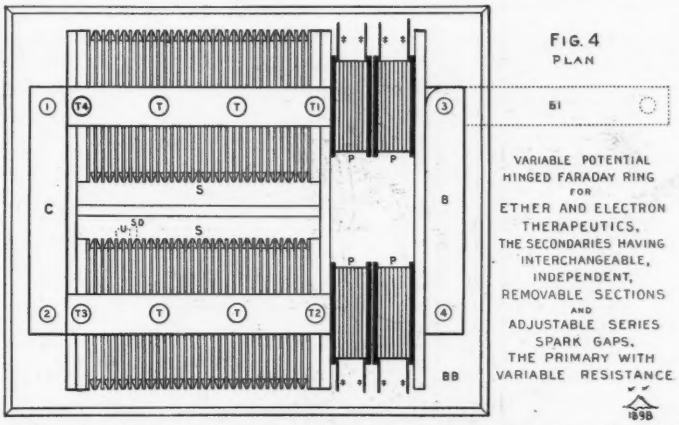
NOTE CLXXIXD2—ON THE CONSTRUCTION OF A TRANSFORMER FOR ETHER AND ELECTRON THERAPEUTICS.

The transformer here illustrated is of the type described in the last note. It has been repeatedly shown in earlier papers that alternating currents were not suited for exciting the primary of a transformer to be used in operating X-light tubes for use in diagnosis where a steady light and delicate adjustments were necessary, unless some means of rectifying the current in the secondary were employed. The best means of doing this will be illustrated in a future note. Unrectified currents are, however, of value in tubes for therapeutic purposes where a steady light and delicate adjustments are of less importance than the ability to use large currents for long periods without the annoyance of a break in the primary cir-



NOTE 179D2—FIG. 1.—HINGED FARADAY RING WITH TWO SECONDARIES FOR USE IN ETHER AND ELECTRON THERAPEUTICS.

cuit. No breaks at present available are perfectly satisfactory as they waste most of the energy as heat and require attention. Apparatus for physicians requires to be as simple as possible, for anything in the shape of mechanism which distracts attention from the patient is objectionable. The transformer here illustrated is valuable for diagnostic work—if a rectifier or a double focus tube is used—and for therapeutic purposes; especially for exciting my derma ray tubes[1] which when placed in a case with a handle, as shown in Fig. 2, note clxxix, and connected with the transformer by flexible cords, are very convenient to operate and give little more trouble than an incandescent lamp.



NOTE 179D2—FIG. 4.—VARIABLE POTENTIAL HINGED FARADAY RING WITH TWO SECONDARIES WHICH MAY BE USED IN SERIES OR INDEPENDENTLY, AND PROVIDED WITH THE ARRANGEMENTS FOR VARYING THE POTENTIAL ILLUSTRATED AND DESCRIBED IN NOTE CXII.

The sections of the secondary are free from each other and from the tube separating them from the core; therefore when a section is injured the end bar of the coil may be unlocked, turned back on its hinge, the injured section easily removed and replaced by a new section. The primary is arranged to allow the sections to be used singly, in series, or parallel. Multiple series spark gaps enable the vacuum tubes to be operated over a considerable range in resistance.

When this transformer is excited by the ordinary 110-volt, sixty-cycle street cur-

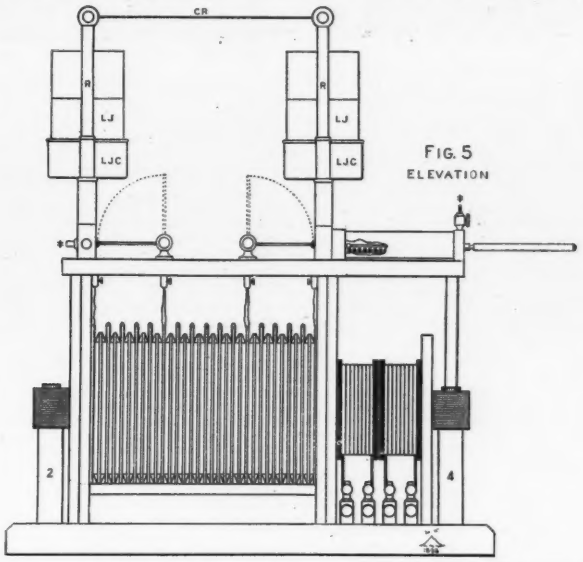
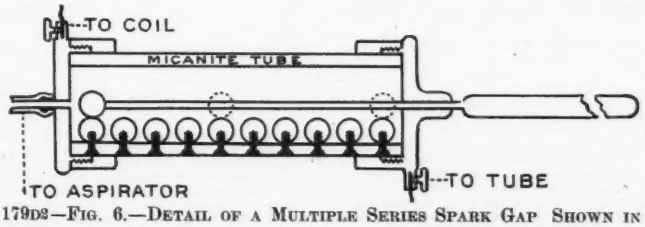


FIG. 5.—HINGED FARADAY RING FOR ETHER AND ELECTRON THERAPEUTICS.

rent, the current being used to light a single-focus X-light tube, the same clear demarcation of the tube is seen as when it is excited by the so-called unidirectional currents from static machines. The anode line is as sharp. The tube in front of the anode is bright yellow and behind the anode blue, whichever way the tube is connected with the transformer.[1]

To secure the greatest efficiency from the transformer, a special dynamo is required in which the rate of change is higher than in commercial alternating cir-



NOTE 179D2—FIG. 6.—DETAIL OF A MULTIPLE SERIES SPARK GAP SHOWN IN FIG. 5.

It consists of a micanite tube containing a row of metal balls, as shown in note cxii. Instead of attaching the balls to a strip of mica, as in the illustrations to notes cxii, cxxxvii, cxl and clxxixD, holes are bored through the wall of the micanite tube, through which pass screws which clamp the balls to the wall of the tube. Multiple series spark gaps require to be enclosed to prevent the nitrogen acids from irritating the respiratory organs. The gas should be drawn off from the spark gaps by an aspirator, as described in note cxxii and illustrated in notes cxii and cxl, Fig. 6

cuits. This plan of exciting an open-cir-

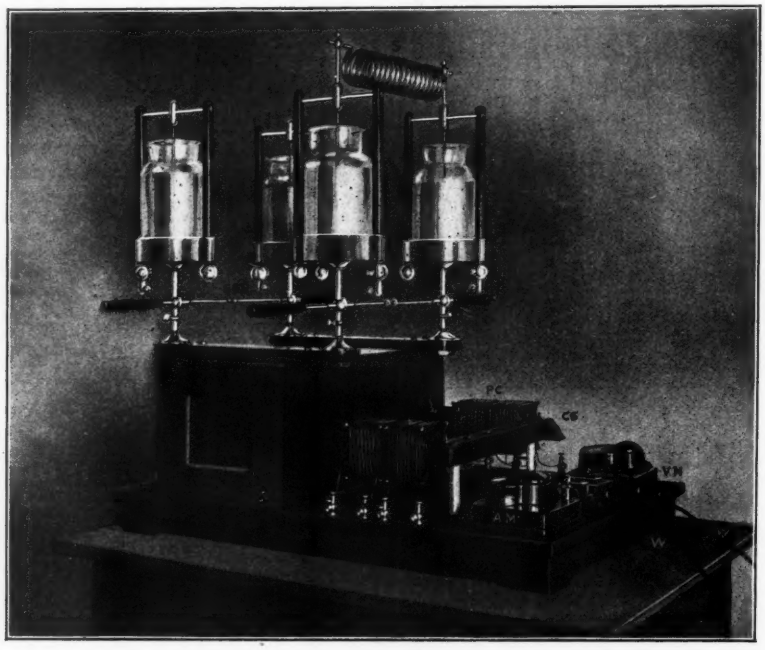
[1] Refer to note clxxiv, and for description of tubes to notes clxvi and clxvii. As one of my friends has recently said derma rays were X-rays, it may be well to mention a difference. When Lenard brought the cathode rays out of a vacuum tube he found he was observing a complex radiation. Though he did not give separate names to his rays, any one who will repeat his experiments will find both X-light and derma rays. Rœntgen, finding that some of Lenard's rays would show the bones, gave to these rays a specific name, the X-rays, and in these notes the term derma rays has been applied to other Lenard rays which do not show the bones because they are too much absorbed by the superficial layers and too much scattered in the tissues. They penetrate black paper and pass through thin layers of glass, in these ways differing from ultra-violet light. After passing through thin glass or black paper they will illuminate a screen of platinocyanide of barium. They are produced from a tube whose resistance is so low the particles of the cathode stream do not strike the target with sufficient velocity to produce X-light, though X-light can be obtained from a derma-ray tube if the generator has sufficient electromotive force to drive the cathode stream particles rapidly through the dense mist of low-resistance tube. The derma rays was selected to distinguish these Lenard rays from others because of their good effect in skin diseases due to their being largely absorbed by the superficial tissues which they ionize.

[1] When powerful transformers are employed in therapeutics, especially when they are used to excite vacuum tubes which are brought in contact with the body or inserted in the mouth or other cavities, insulating platforms should be used.

cuit transformer has already been recommended.[1] The method is not likely to be much used at present because of the expense of the special dynamo. On this account the transformer was constructed to use the street alternating 110-volt, sixty-cycle current, or where this was not available a small commercial dynamo producing a similar current.[1] For a transformer of this type when used to produce ultra-violet light or electrons for therapeutics, the primary may have four sections, each of forty-nine turns of No. 10 double cotton-covered copper wire. The secondary may be in thirty-eight coils, each containing 900 turns of No. 32 double cotton-covered copper wire. For the method of preparing, insulating and connecting these coils refer to notes cxii, cxxxvii, clxxixA, where these matters are fully illustrated in connection with open-circuit transformers. The primary is arranged to use the sections in series, each section independently, or two or more in parallel. The voltage which may be obtained is always sufficient for the ultra-violet or electron arc when the transformer is excited by the current mentioned. Where a lower voltage is desired from the secondary, it may be obtained easily as the variable potential principle, illustrated and described in notes cxii, cxxxvii and cxl, is employed in the construction of the secondary. When a higher voltage is required, instead of arranging the secondary and primary as in Fig. 1, note clxxixD, they may be equally divided on the two arms as in Figs. 3, 4, 5, 7 and 8. As there are two secondaries there are double the number of turns of wire, because the number of sections is doubled. The two last forms are more suitable for exciting vacuum tubes used to produce derma rays as the reserve of energy allows the tubes to be worked over a greater range of resistance by means of spark-gaps in series with the tube.[1]

Transformers of this type are convenient for exciting the primary of a Tesla coil for use in therapeutics. Designs will be given in a future paper on Tesla coils which have been made to form part of the transformers illustrated in this note. These types of transformer are perhaps the most convenient source of ultra-violet light to be used directly or for the production of electrons, as recommended in note clxxix, for ionizing the tissues in skin diseases. For these purposes the arc should be between aluminum terminals, as Lyman, who has photographed the spectrum below 1,200, has found strong lines there from aluminum.

(To be concluded.)



NOTE 179D2—FIG. 7.—PERSPECTIVE VIEW OF THE HINGED FARADAY RING, SHOWN IN FIGS. 4 AND 5—WITH THE SECONDARY SECTION IN SERIES.

This transformer is of the type illustrated in Figs. 4 and 5, though some of the details of construction are different. The core is unusually light to make the transformer portable, being only four centimetres square in cross-section. It is provided with a hinge like those already illustrated. To facilitate closing, each of the plates of one of the side bars is made one millimetre longer than the next, allowing the sheets to be inserted one at a time. This is a point of practical importance. The construction is shown at CS. The primary coils (PC) are wound more openly, air spaces of three millimetres being left between the layers and between the strands of each layer to allow of a larger current being used without injurious heating. The primary contains four coils, each having forty-nine turns of No. 10 copper wire. The secondary contains thirty-eight sections, constructed on the plan illustrated in notes cxii and cxxxvii, each section having two coils attached to a micanite plate one millimetre thick. Half the coils are wound with No. 32 copper wire, each containing nine hundred turns. The other coils are wound with No. 34 wire, and each coil contains fifteen hundred turns.

There are four Leydens as in the transformer illustrated in Figs. 4 and 5. Two are connected with the terminals of the united secondaries. If the vacuum tube is attached to the terminals FT of the secondaries, which are connected by bringing the spark-gap rods SGR together, the transformer has sufficient voltage to excite a double focus or Roentgen X-light tube and amperage enough to melt even a cooled target unless it is cooled by a constant circulation as described in note i. It will also excite a single focus or Crookes X-light tube. It is not particularly recommended for exciting any form of X-light tube for diagnosis, because, as already frequently stated, a generator should have a very high voltage for this purpose. For therapeutics the case is different, as quantity is of more importance than ability to regulate the X-light with great nicety.

The transformer is especially suited for exciting derma-ray tubes, either of the type shown in Fig. 2 or of other types having two terminals from both of which cathode streams are sent forward to the wall of the tube nearest the patient, there producing the derma rays by their impact. Little energy is required in the primary of the transformer when it is used for this purpose with a small derma-ray tube. Enough current will pass through a fifty-candle, 110-volt Edison lamp in series with the primary, or, if the condensers are used, the tube will be lighted with the current which will pass through a similar thirty-two candle-power lamp. The transformer is valuable for producing the ultra-violet arc for treating lupus. For this purpose a greater current is used in the primary. The arc should be between aluminum terminals. If it is about three millimetres long it is almost noiseless and so cool that it may be brought almost in contact with the patient's skin. The aluminum, high-voltage arc was recommended in earlier papers as far superior to the low-voltage arc between carbon or iron terminals, because most of the energy of the current is converted into short ether waves on which we depend for ionizing the tissues to get therapeutic effects, while with the low-voltage arc most of the energy is converted into the long heat waves which are not useful and require complicated apparatus to absorb them. For the high-voltage arc the inner coating of the condensers is connected, otherwise the arc is a pale yellow flame. The transformer is also useful for producing the electron arc mentioned in note clxxix. When it is used for this purpose the wires leading to the arc are attached at FT and the inner coatings of the Leydens connected. In this case, also, the energy in the primary should be considerable. Absence of heat and ability to bring the source of electrons in near contact with the patient are valuable features. As it has been shown by the experiments on animals and on man, briefly mentioned in earlier papers, that these electrons have the same therapeutic effects as the beta radium rays; a transformer for producing them should be interesting. The transformer is also valuable when it is desired to subject a patient to rapid polarizations of the ether in his tissues, such, for example, as is obtained by placing a part or the whole of his body in a solenoid through which alternating currents from the secondary of the Faraday ring are passing. For this work connection is made between the solenoid and the main terminals of the transformer at FT. If more rapid changes in the ether are desired, the inner coatings of the Leydens should be connected by a rod, or the solenoid may be placed in series with the inner coatings of the Leydens in a similar way to the small solenoid shown in Fig. 8. Still more rapid ether changes may, of course, be obtained by connecting the solenoid with the terminals of the secondary of the Tesla coils which were designed for this apparatus. These coils, as already stated, will form the subject of a future note, as they require many illustrations and a detailed description. The transformer can be used with direct currents if some form of break is employed. When excited by alternating currents from commercial circuits it is the most convenient source of ultra-violet light, derma rays, X-light and electrons for examining minerals. As one large enough could be sold for seventy-five dollars, it is hoped that some manufacturer will make them commercially available, for no examination of a mineral can be considered to be complete until the specimen has been bombarded by electrons and short ether waves. A transformer of the size illustrated in Fig. 1 is large enough for these examinations and weighs so little that it can be easily moved about by one man. A voltmeter (VM) and an ammeter (AM) are mounted on the base, as it is important to know the amount of energy employed in the treatment. A fuse (BF) is desirable for preventing too strong a current. The wires from the commercial circuit are attached to the switch.

New Form of X-Light Tube.

Dr. J. Mount Bleyer, of New York city, who has for many years made a special study of light phenomena, has discovered a new composition of glass from which has been constructed an X-ray tube, which Dr. Bleyer claims may be used to generate both X-rays and the bi-ultra violet rays at the same time. The quality and richness of the rays emitted from this tube are considered by Dr. Bleyer to be the finest he has observed. The perfection of a tube of this nature will place in the hands of therapeutists an instrument of much value in the treatment of lupus and other allied diseases. Dr. Bleyer credits Mr. G. J. Monohan with the construction of the tube.

[1] Refer to note clix.

[1] A 1,200-watt dynamo, giving both alternating and pulsating currents, costs about $140.

[1] Refer to notes vi, xxxix, lxxii, cxii, clx for the value of high potentials in X-light work.

THE ADVISABILITY AND METHODS OF GROUNDING THE NEUTRAL ON HIGH-POTENTIAL ALTERNATING-CURRENT GENERATORS.[1]

BY GEORGE N. EASTMAN.

It is the principal object of this paper to present a few conditions which will arise on any alternating-current system, resulting in a production of dangerous potentials relative to earth, and to show that these conditions will only arise on a system which is insulated from the earth. The conditions and problems presented, when carefully considered, will, I believe, show that any advantages which may be obtained by operating a system insulated from earth, will be more than offset by the liability of obtaining high potentials relative to the earth, as hereinafter described.

The relative potentials between any part of a high-potential alternating-current system and ground will be governed by the distribution of the electrostatic capacity of the line conductors and the apparatus connected thereto. In general, the insulation resistance to ground will have practically no influence on the relative ground potentials. This will be readily seen by comparing the insulation resistance of an ordinary circuit with its reactance of condensance, for example. The insulation resistance of a circuit one mile in length, consisting of two 4/0 conductors, placed twelve inches apart in air, would normally exceed 500 megohms. The reactance of condensance between the conductors with sixty cycles, would be approximately 160,000 ohms. In a 4/0, paper-insulated, 10,000-volt, lead-covered cable, the insulation resistance between any conductor and the lead should exceed 500 megohms. The reactance of condensance between a conductor and lead will be approximately 14,000 ohms.

Any condition which will arise on a high-potential alternating-current system, which is insulated from earth, disturbing the relation of electrostatic capacities in any part of the system, will affect the ground potentials throughout the entire system. This can be best shown, by considering the problems which will arise in a particular installation. For this purpose, I have chosen a four-wire, three-phase system and will describe some conditions, the consideration of which has led the engineer of the Chicago Edison Company and Commonwealth Electric Company to permanently ground the neutral of all their high-potential alternating-current generators.

In December, 1900, the Commonwealth Electric Company, of Chicago, completed a new power station in which was installed one 500-kilowatt, and one 1,000-kilowatt, star-wound, sixty-cycle, three-phase, alternating-current generators, designed to operate at a star potential of 2,300 volts or 3,980 volts between phases.

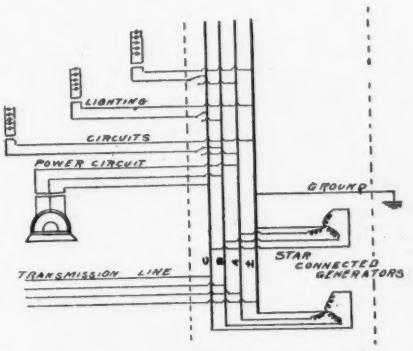


FIG. 1.—DIAGRAM OF SYSTEM, SHOWING PARALLEL OPERATION OF GENERATORS.

The switchboard was so arranged that the distributing circuits could be operated all in multiple on one four-wire bus with parallel operation of generators or divided between two buses with the generators operating independently. The distributing system consisted of 350 miles of overhead conductor and 14.5 miles of underground cable, the greater part of which had previously been operated as single-phase circuits at a potential of 2,000 volts. These circuits were rearranged and subdivided into two-wire, single-phase lighting circuits, three-wire, three-phase power circuits, and two four-wire, three-phase transmission lines, connecting the generating station to a distributing substation. A diagram of system showing parallel operation of generators is given in Fig. 1.

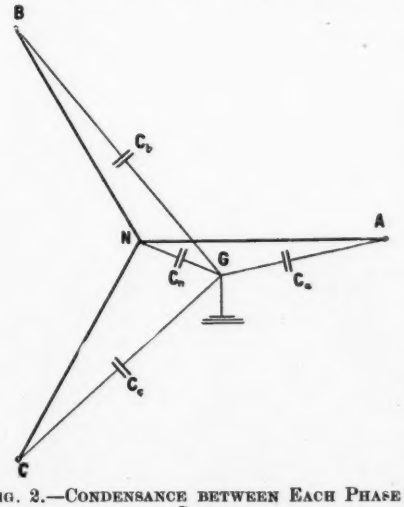


FIG. 2.—CONDENSANCE BETWEEN EACH PHASE AND GROUND.

Since the three-wire circuits have no neutral and the four-wire transmission lines have but one neutral conductor for the three-phase conductors, the total length of line conductors connected to the neutral bus was less than the total length of line conductors connected to the phase buses. Of the 364.5 miles of circuit conductors, 158 miles of overhead lines and six miles of underground cable were connected to the neutral bus, the remaining 192 miles of overhead lines and 8.5 miles of underground cable being distributed between the phase buses.

As shown in Fig. 1, the lighting circuits are so arranged that they may be operated between the neutral and either of two-phase buses. This arrangement being made for the purpose of distributing the lighting load equally between the three phases of the generators.

It is obvious, that in this system the number of miles of circuit conductors connected to each of the three-phase buses will depend on the length and load of the lighting circuits. The chances, therefore, of obtaining an equal length of circuit conductors on each phase bus would be very remote. Assuming that this condition was obtained, there would be connected to each phase bus sixty-four miles of overhead and 2.8 miles of underground. This condition will represent a system in which the electrostatic capacities will be balanced. The condensance of the entire system between neutral and ground will be 4.3 microfarads. The condensance between each phase and ground will be 2.2 microfarads. This condition is represented diagrammatically by Fig. 2. ABCN represents the star diagram of pressure. The condensance between phase conductors and ground being represented by C *a*, C *b* and C *c*, and the condensance between the neutral and ground being represented by C *n*.

With sixty cycles, the reactance of each phase condenser which connects the phase to ground will be 1,700 ohms. The reactance of the neutral condenser which connects the neutral to ground will be 900 ohms. It is obvious, that with this condition the voltage impressed on each phase condenser will be the same, and so long as the system is free from ground no potential will exist between the neutral of system and ground. Should one phase conductor become grounded in any manner, the relative potentials between the system and ground will be changed.

An equation was derived in the following manner to determine the relative

[1] Read before the National Electric Light Association at its twenty-seventh convention, held at Boston, Mass., May 24, 25, 26 and 27, 1904.

potential which will exist between the neutral of the system and ground when one phase becomes grounded through a purely ohmic resistance.

Substituting values for the reactance of condensance, Fig. 3, let C *a*, C *b*, C *c* and C *n* represent the reactance of condensers C *a*, C *b*, C *c* and C *n* respect-

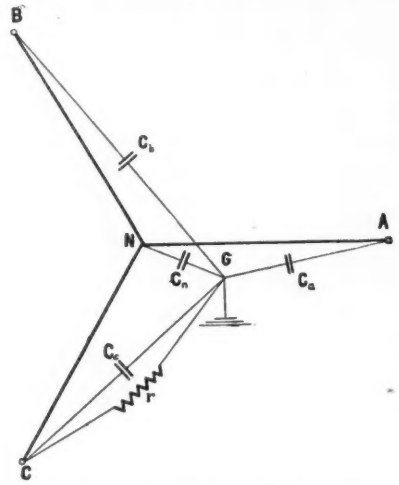


FIG. 3.—REACTANCE OF CONDENSANCE.

ively and *r* represent the ohmic resistance through which the C phase is grounded.

Let I *a*, I *b*, I *c* and I *n* represent the current which will flow through the condenser C *a*, C *b*, C *c* and C *n*, respectively, and I *r* the current which will flow through the resistance *r*.

Since the sum of the currents meeting at a mesh point is 0, then

$$I\,a + I\,b + I\,c + I\,n + I\,r = 0 \quad (1)$$

From Fig. 3

$$I\,a = \frac{GA}{j\,C\,a} = \frac{GN + NA}{j\,C\,a} \quad (2)$$

$$I\,b = \frac{GB}{j\,C\,b} = \frac{GN + NB}{j\,C\,b} \quad (3)$$

$$I\,c = \frac{GC}{j\,C\,c} = \frac{GN + NC}{j\,C\,c} \quad (4)$$

$$I\,n = \frac{GN}{j\,C\,n} \quad (5)$$

$$I\,r = \frac{GC}{r} = \frac{GN + NC}{r} \quad (6)$$

Substituting current values in (1) and solving, when star pressure = 2,300 volts.

$$NG = \frac{r\,C\,n\,[2300\,C\,b\,C\,c - 1150\,C\,a\,C\,b - 1150\,C\,a\,C\,c] + 1992\,C\,a\,C\,b\,C\,c\,C\,n - j\,C\,n\,[1150\,C\,a\,C\,b\,C\,c + r\,(1992\,C\,a\,C\,b - 1992\,C\,a\,C\,c)]}{r\,C\,n\,C\,b\,C\,c + C\,n\,C\,a\,C\,b + C\,n\,C\,a\,C\,c + C\,a\,C\,b\,C\,c + j\,C\,n\,C\,a\,C\,b\,C\,c} \quad (7)$$

When C *a* = C *b* = C *c*

$$\text{then } NG = \frac{1992 - j\,1150}{r\,\frac{3}{C\,c} + \frac{1}{C\,n} + j\,1} \quad (8)$$

From equation 8 an expression can be obtained for the tangent of the angle ANG. It is easier, however, to substitute numerical values in equation 8 and lay the angle off graphically, than to solve for the tangent of the angle.

In equation 8, taking for the values of C *a*, C *b*, C *c* and C *n*, the value of reactance considered, the pressures to ground have been determined for values of *r*, varying from infinity to 0.

When r = inf.	NG = 0	AG = 2300	BG = 2300	CG = 2300
When r = 2000	NG_1 = 394	AG_1 = 2020	BG_1 = 2675	CG_1 = 2265
When r = 500	NG_2 = 1315	AG_2 = 2115	BG_2 = 3610	CG_2 = 1885
When r = 125	NG_3 = 2165	AG_3 = 3450	BG_3 = 4190	CG_3 = 755
When r = 0	NG = 2300	AG = 3980	BG = 3980	CG = 0

This condition can be represented diagrammatically as shown in Fig. 4. Referring to figure, with C grounded through a resistance of 500 ohms, the ground will be located at the point G 2 on diagram, and so long as the grounding resistance does not change the system will operate with the relative potentials to ground given in the above table. It will be noted that with a resistance of 125 ohms, the potential between B phase and ground is 4,190 volts, which exceeds the delta pressure of the system.

Diagram Fig. 5 represents a condition which may be obtained where the ground

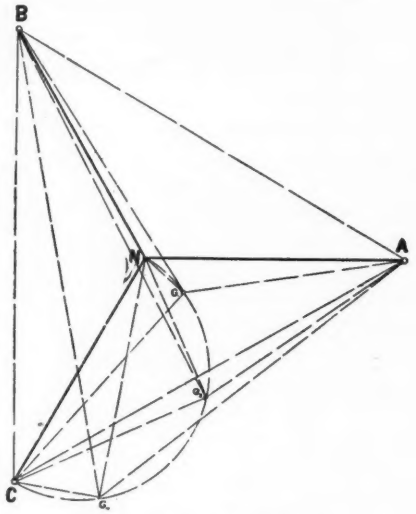


FIG. 4.—PRESSURE TO GROUND.

is of an inductive character. Let N, A, B and C represent the bus-bars of the four-wire three-phase system. One circuit is shown connected between the bus-bars N and A. The capacity of the neutral conductor of this circuit is represented by the condenser C. The capacity of the rest of the system is represented by the condensers C *n*, C *a*, C *b* and C *c*. In case the neutral wire of the circuit should become disconnected from the bus-bar, the phase A will be grounded through the primary of the transformer T in series with the condenser C *d*. Should the neutral of the circuit become grounded and disconnected from the neutral system, the phase A would be grounded direct through the primary of the transformer T. This is but one example of the many conditions by which the system would

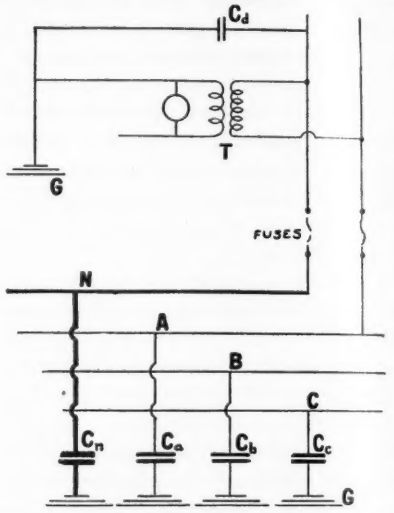


FIG. 5.—GROUND OF INDUCTIVE CHARACTER.

become grounded through an inductive reactance.

The following equation was derived for the purpose of determining the potentials which would exist when a phase

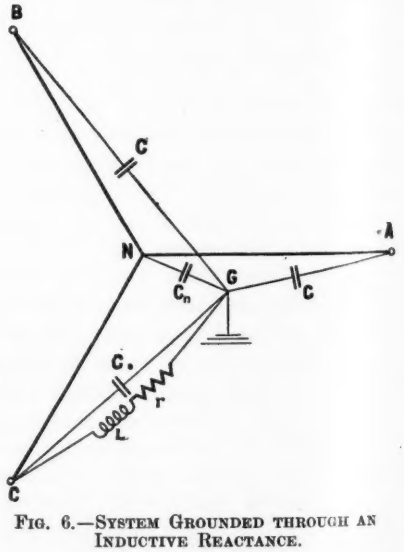


FIG. 6.—SYSTEM GROUNDED THROUGH AN INDUCTIVE REACTANCE.

conductor of the system becomes grounded through an inductance reactance, as represented in Fig. 6. The reactance of each phase condenser being the same, it is represented by *x*. The reactance of the neutral condenser is represented by *y*. The ohmic component of the grounding

reactance is represented by r, and the inductive component is represented by w. Let I a represent the current in A phase condenser, I a the current in B phase condenser, I c the current in C phase condenser, I n the current in the condenser C n, and I r in the current in r L.

$$\text{I } a = \frac{\text{GA}}{j\,x} = \frac{\text{GN} + \text{NA}}{j\,x} \qquad (a)$$

$$\text{I } b = \frac{\text{GB}}{j\,x} = \frac{\text{GN} + \text{NB}}{j\,x} \qquad (10)$$

$$\text{I } c = \frac{\text{GC}}{j\,x} = \frac{\text{GN} + \text{NC}}{j\,x} \qquad (11)$$

$$\text{I } n = \frac{\text{GN}}{j\,y} \qquad (12)$$

$$\text{I } x = \frac{\text{GN} + \text{NG}}{r - j\,w} \qquad (13)$$

$$\text{I } a + \text{I } b + \text{I } c + \text{I } n + \text{I } r = 0 \qquad (14)$$

Substituting the current values in I and solving

$$\text{GN} = \text{NC} = \frac{x\,y}{w\,(3\,y + x) - x\,y + j\,r\,(3\,y + x)} \qquad (15)$$

Substituting for GN its vector value, $-a - j\,b$ where $a = 1150$ and $b = 1992$

$$\text{GN} = \frac{-x\,y\,(a + j\,b)}{w\,3\,y + x) - x\,y + j\,r\,(3\,y + x)} \qquad (16)$$

$$\text{and tan ANG} = \frac{(b\,w - a\,r)\,(3\,y + x) - b\,x\,y}{(a\,w - b\,r)\,(3\,y + x) - a\,x\,y} \qquad (17)$$

Substituting in equation 16, the value of 1,700 ohms for x, and the value of 900 ohms for y, and assuming the resistance in series with inductive reactance as zero; when w is equal to infinity, the potential between neutral and ground is zero; when w has a reactance of 348 ohms, the potential between neutral and ground would be infinite, and when w has a reactance of zero ohms, the potential between neutral and ground would be 2,300 volts which is the Y-pressure of the system.

This condition is represented diagrammatically in Fig. 7. As the reactance is varied from infinity to 348 ohms the potential between neutral and ground travels along the line CG_1 to infinity. As the reactance is further decreased to zero, the potential decreases from infinity along the line G_2C until the point C is reached. This is purely a theoretical case, it being impossible to obtain an inductive reactance which would not have an ohmic component; but its consideration is of value in showing what influence the inductive component of a ground has in determining the relative potentials between the system and ground.

Fig. 6 represents a condition of a ground through an ohmic resistance in series with an inductive reactance. If we fix the inductive reactance at a value of 695.5 ohms and vary the value of resistance from zero to infinity, it will be found that the ground potential will follow the curve shown in Fig. 8. With r equal to zero, the potential between neutral and ground will be 2,300 volts and the ground will be located at point G in diagram; with r equal to 200 ohms, the potential between neutral and ground will be 1,386 volts, the ground will be located at G 1 in diagram; with r equal to infinity there will be no voltage between neutral and ground.

All the foregoing examples apply to the system when the electrostatic capacities are balanced. As previously stated, the chances of obtaining such a condition would be very remote. The relative potentials which will exist between the system and ground can be obtained from equation 7, for any arrangement of the electrostatic capacities. For example, consider the circuits are so arranged that in Fig. 2 the reactance of C a = 1,150 ohms, C b = 2,270 ohms, C c = 2,270 ohms, and C n = 900 ohms.

Substituting in equation 7 it will be found that for this condition the difference of potential between the neutral and ground will be 345 volts. Substituting in equation 7 the values of r previously considered.

When r = inf. NG = 345 AG = 1955 BG = 2395 CG = 2395
When r = 2000 NG_1 = 710 AG_1 = 1690 BG_1 = 2915 CG_1 = 2460
When r = 500 NG_2 = 1570 AG_2 = 2030 BG_2 = 3870 CG_2 = 2050
When r = 125 NG_3 = 2200 AG_3 = 3350 BG_3 = 4270 CG_3 = 960
When r = 0 NG = 2300 AG = 3980 BG = 3980 CG = 0

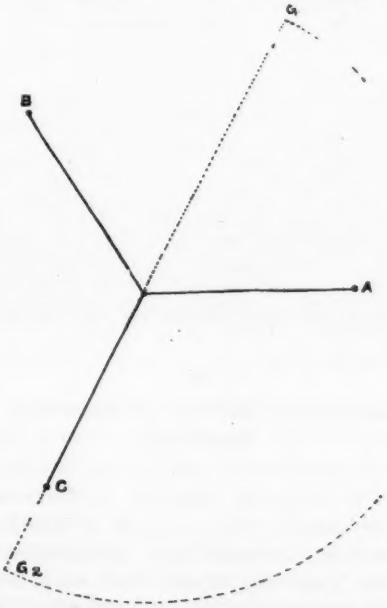


FIG. 7.—Y-PRESSURE OF SYSTEM.

Fig. 9 represents this condition and shows the manner in which the potentials vary when r is varied from infinity to 0.

This one example is sufficient to show the manner in which a ground will affect a system when the electrostatic capacities of the system are not balanced. The results obtained by an inductive ground on the system can be inferred by comparing the effects produced by an ohmic ground under the two conditions considered.

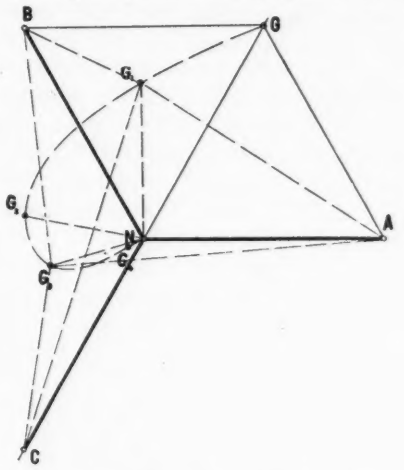


FIG. 8.—GROUND POTENTIAL CURVE.

It will readily be seen that grounding the neutral bus will eliminate the chances of obtaining high potentials between the system and ground as described in the foregoing examples. In case of a solid grounded neutral bus any ground on the phase conductor will either be burned off or the circuit will be cut off from the system by means of the fuses or circuit-breakers in the station.

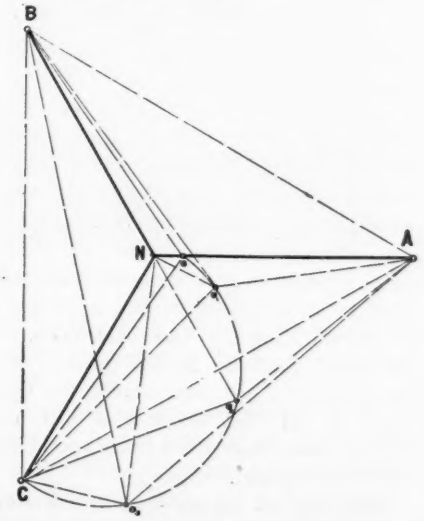


FIG. 9.—VARIATION OF POTENTIALS.

When this system was first put in operation a switch was installed on the conductor leading from the bus-bar to the

ground plate. In order to test for the potential between neutral and ground, this switch was opened and several incandescent lamps were connected in series across the switch. The potential between the neutral bus and ground when switch was opened was approximately 200 volts, but this potential would vary whenever a lighting circuit was thrown over to another phase bus. Sufficient lamps were connected to withstand a potential of 1,500 volts without burning out, and the system allowed to operate in this manner free from ground with exception of these lamps. During a sleet-storm, the evening following the installation of the lamps, the lamps were suddenly burned out and simultaneous with this occurrence a discharge was noted on the lightning arrester installed in the station. The following morning a five-kilowatt lighting transformer was discovered burned out, which showed indications of having been subjected to a destructive high potential. The neutral fuse of the circuit had been blown and primary fuse block of the transformer had been destroyed. After this case of trouble, the neutral bus-bars of the system were permanently grounded and the system has been operated in this manner ever since. No case of trouble has yet been obtained on the system, with the exception of lightning discharges, in which high-potential discharges to the ground have been noted.

The conditions which have been considered in the examples shown, all refer to a four-wire three-phase system. Similar results will be obtained in the consideration of any three-phase three-wire system or of any alternating-current polyphase or single-phase system which is operated free from ground. The consideration of the conditions which have been described led to the grounding of the neutral of the generators on the 9,000-volt, three-phase, twenty-five-cycle system of the Chicago Edison Company. Since the ground has been placed on the generators, but one case of trouble has developed in which there appears to have been excessive potentials on the system relative to ground. In investigating this case of trouble, it developed that the neutral ground on the generators had been opened the day previous and that the trouble had occurred when the system was operating free from ground.

The principal objection which has been raised to the grounding of the high-potential alternating-current generators is that when a ground is obtained on any phase conductor a heavy short-circuit will flow, which will be liable to cause resonance resulting in a high-potential strain on the system. I have shown that a system could be operated continuously with a ground on one phase and have cited examples from which the current through the ground could be calculated, if the reactance is known. In any system operating multiple conductor underground cable, it is obvious that should a ground be obtained on one conductor in the cable, the ground current would be sufficient to destroy the insulation between the conductors resulting in establishing a short-circuit between the phases of the system which would be as disastrous as a heavy short-circuit between one conductor and ground.

It has also been suggested that a resistance be connected between the neutral of the generators and ground which would limit the flow of current produced by a ground on the system. This would also have the effect of transferring the short from between phase and neutral to a short between phases.

I believe that the proper manner of grounding the neutral of the generators is through as low a ground resistance as can be possibly obtained; in this manner fixing the maximum potential which can be obtained between the system and ground at normal potential which will exist between the neutral of the generator and its phase terminal. The best endorsement of grounding in this manner is the success which has been met with by the Chicago Edison Company and the Commonwealth Electric Company in operating their systems grounded.

These systems have been operated for a period of four years, during which time the systems have apparently been entirely free from the high-potential breakdowns which have been met with by other systems of a similar character which were operated free from ground. No elaborate static discharge devices have been installed, and whenever a ground was obtained upon a circuit which was not equipped with a time-limit device the circuit has been opened successfully and the operation of the system has not been affected.

American Institute of Electrical Engineers.

A photogravure plate of the members of the American Institute of Electrical Engineers is to be prepared by Barclay Brothers, engravers and photographers, New York city, which when completed, will represent the members and associates assembled together. It will be about forty by thirty inches, and similar to those which have already been prepared for other engineering societies.

ELECTRICALLY OPERATED SUBMARINE MINES.

BY WALDON FAWCETT.

The extensive employment of submarine mines in the war in the far east and the repeated demonstrations of their deadly effectiveness have served to direct considerable attention to this very important class of war utilities. Electricians have reason to feel an especial interest in the subject, not only because the major portion of the mines used in the struggle in the Orient and in other recent conflicts are electrically operated, but also by reason of the fact that the future development of mines for harbor defence is largely dependent upon electrical science.

Indeed, the present achievements of this very extensive and important branch of naval warfare have been rendered possible only by the introduction of electricity and high explosives. In the mind of the uninitiated submarine mines of all kinds are, as a rule, inevitably associated with torpedoes, but as a matter of fact they constitute a much more recent development. The first recorded destruction of a ship by a torpedo dates back to the beginning of the last century when Fulton managed to sink a small vessel experimentally by affixing a charge to her hull by means of a submarine boat.

It was not, however, until the Russian war that mines were seriously tried in actual warfare. As employed by the Czar's engineers in the defence of the Baltic ports during that war they did not prove wholly successful, but nevertheless two British men of war, the Merlin and Firefly, were badly shaken up by the explosion of these initial mines. These early Russian mines, it should be explained, were of the type known as the "mechanical"—that is, they carried their own means of firing and were independent of any outside agency such as electricity. Modifications of these mines are in use to some extent to this day.

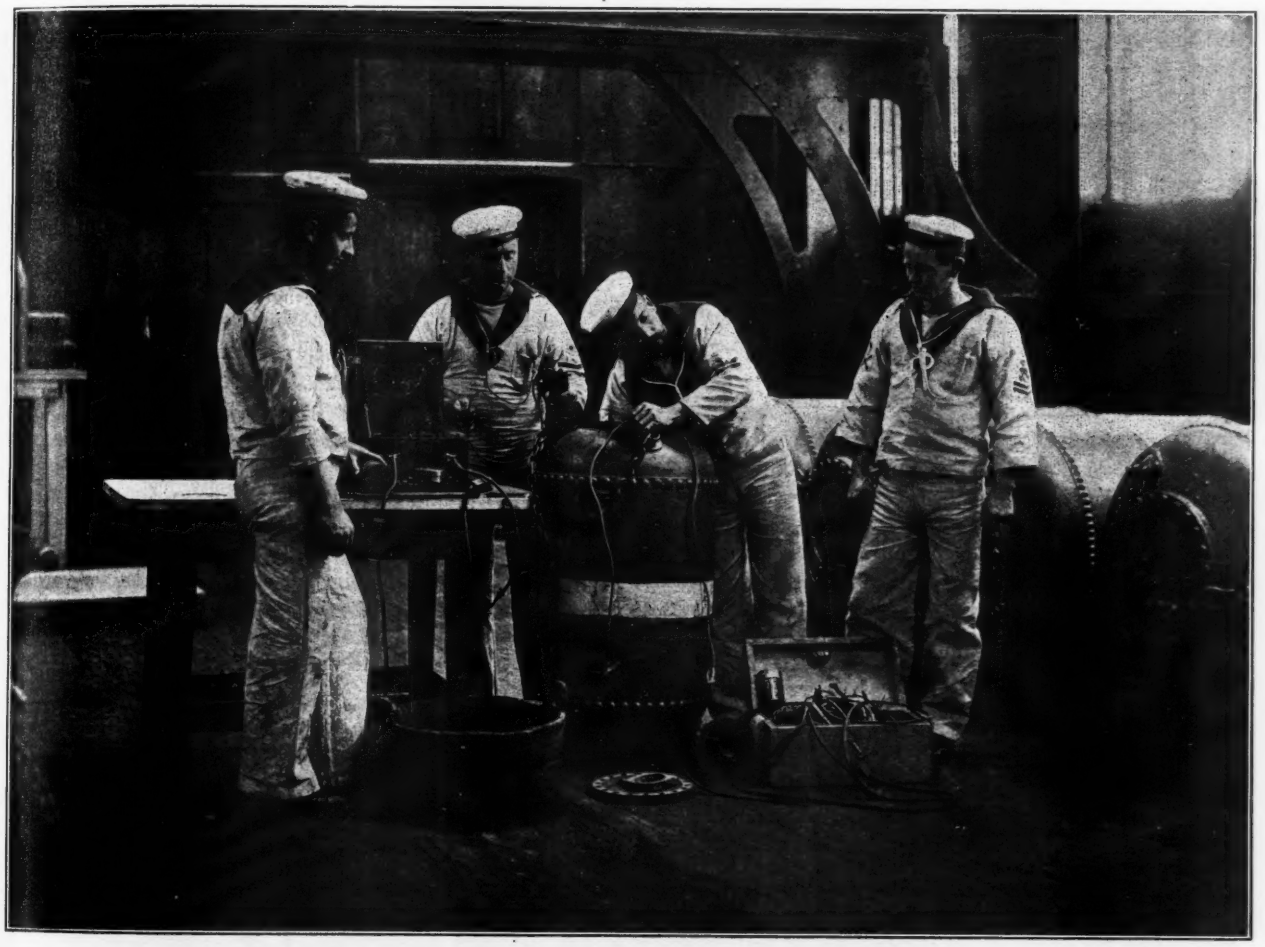
In naval and military circles to-day, however, these mechanical mines are generally regarded as makeshifts, which are undesirable for the obvious reason that they are equally dangerous to friend and foe, and which should only be employed when peculiar conditions render impracticable the utilization of the electrical mine with its paraphernalia of cables and batteries. The electrical mine, which is so vastly superior to every other similar agent of destruction, was first used in the Civil War. The electrical mines, or "ground mines," as they are sometimes

designated, are of very simple construction and are fired by means of an electric current from the shore.

A representative electrical mine consists primarily of a buoyant iron case containing a charge varying with circumstances from 200 pounds of gunpowder up to as much as 700 or 800 pounds of gun-cotton. Gunpowder was used almost exclusively in the earlier electrical mines, but it has been almost wholly superseded by gun-cotton or other high explosive for the reason that the latter is more powerful and is not affected by dampness. Indeed, gun-cotton is generally used in a wet condition.

The fuse for firing is a very simple affair, consisting of a cylinder two or three inches long, containing a little fine powder at the big end while the small end is filled with fulminate of mercury which is a tremendously powerful detonator. Through the ebonite head are led two thick copper wires which are connected together inside the fine grain powder by a very thin platinum-silver wire. The electrical battery on shore is connected to one of the thick copper wires of the fuse by a special cable which is led into the mine by a water-tight joint. When it is desired to fire the mine, a firing key in the circuit is pressed and a current of electricity sent along the cable. It flows easily along the thick copper core and on to the copper wire of the fuse where it is then checked by the piece of thin platinum-silver wire which rises to a red heat. This naturally ignites the surrounding powder and fires the mine.

The mining of harbors with such a system of electrical defence constitutes one of the most highly specialized functions of our military and naval administration. In the first place the selection of a position for an electrical mine field must be made with reference to the shape of the harbor and the disposition of the fortifications. Naturally the mine field is placed to seaward of the forts so that the enemy can not get at the forts because of the mine field nor can their boats destroy the mines or cut the cables because of the forts. The mines are laid down by boats, either singly or in groups of two or three, and the electrical cables taken on shore to some convenient point. For the operation of the mines to the best advantage there are selected two observation stations, located at high points and commanding a good view of the entire mine field. As the mines are laid down the observers at these two stations, which are located at right angles to each other, carefully note the exact position of each mine as laid and record it by putting up a pair of pickets in that direction. In this way the position of any mine can be accurately determined by the operators at the two stations observing together. The electrical circuit is then joined up, there being a distinct circuit for each mine or group of mines, and the two operating or observing stations are further connected by telephone or telegraph or both.



FITTING UP AN ELECTRICALLY OPERATED SUBMARINE MINE ON H. M. S. VERNON.

Under war conditions operators are constantly on duty at both stations, and should a hostile ship approach the mine field close watch is kept, and as the vessel passes over each line of mine pickets the corresponding firing keys for the mine or mines at that point are pressed. Obviously if an enemy's ship passes over the

intersection of two lines of vision from the respective stations the two operators will press the keys simultaneously, the circuit will be completed and the mine fired.

This outline, it should be pointed out, covers nearly the most simple plan of operation for electrical mines. Several nations have of late years adopted systems which while far more elaborate in themselves require but a single observer or operator. The elaboration of the new systems consists primarily of the introduction of more complicated arrangements and delicate instruments for testing and firing the mines. Some of the mines, for instance, are connected with the firing station by telephone, and so long as they are in good working order can be made to buzz like a bee. If the mine fails to respond to its call it is known that something is wrong and it must be raised for inspection.

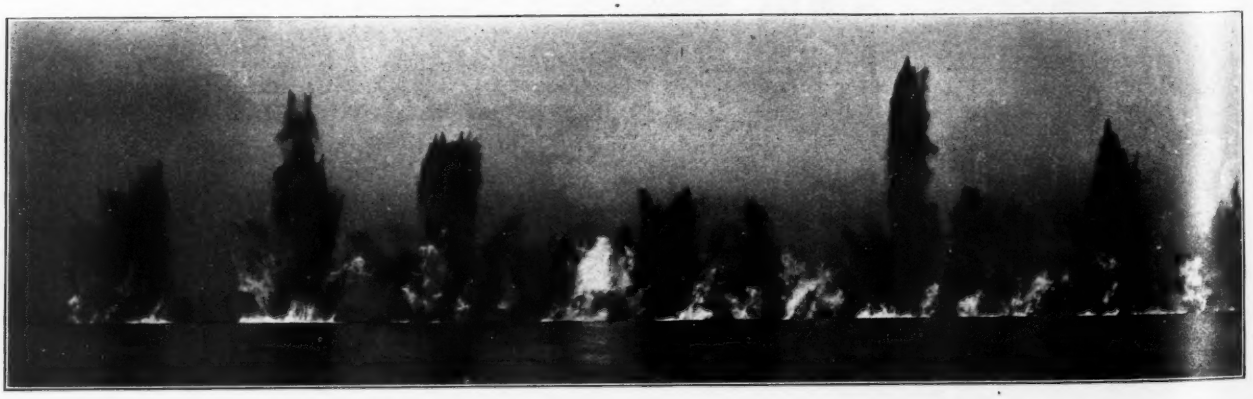
Loading Electrically Controlled Submarine Mines, Preparatory to Mining a Harbor.

The use of mines or stationary torpedoes is by no means confined, however, to the destruction of hostile ships which are attempting to enter a harbor. Mines are also used for destroying other mines and may be placed outside an enemy's port so as to make it dangerous for him to venture out. In the latter case they are called blockade mines, whereas when they are used for destroying other mines they are designated as counter-mines.

The destructive area of an electrically operated submarine mine—also known as a ground mine or observation mine—has been found by experiment to be the area embraced by a circle on the surface of thirty feet radius, so that allowing sixty feet for the breadth of the ship, the mines would be placed across the ordinary mined channel at intervals of 120 feet. By introducing several lines of these mines a channel or harbor can be most completely mined. Mines give the best explosive effect when placed at a depth of about fifty feet.

Under the latest approved system the operator or observer times the firing of the mines by looking through the telescope of an instrument on the platform of which is a plan of the mine field with small metal studs representing the danger area of the various mines. From these studs the electrical wires lead to the mines which they represent. To the telescope itself is connected the battery for producing the electricity. Keeping the centre of the telescope following the enemy's ship it will be appreciated that when the hostile vessel crosses the danger area of a mine, the movement of the telescope will have brought the battery into connection with the stud representing the mine and the electricity flows through so firing the mine. Electrical mines are the only ones which are suitable for use in channels which must be kept open for the ingress and egress of friendly ships, as they are under complete control from the shore, and being placed at considerable depths there is little danger of ships colliding with them.

Counter-mining, in which electricity is also the agent employed, is seldom practicable owing to the impossibility of carrying out the work under gun fire which would almost inevitably be necessary under war conditions. It is obvious, however, that since a 500-pound mine—that is, a mine containing 500 pounds of gun-cotton—will destroy all the mines within a radius of ninety feet, twelve of these mines, such as can be transported at one time in an ordinary ship's launch, will, if properly laid 180 feet apart, clear by their explosion a channel sixty yards wide and 720 yards in length. In many navies, notably the American and British, increased attention is being given to the instruction of regular classes of officers and men in torpedo and submarine mine work and in the schools at Newport, R. I., and on his Majesty's ship Vernon (stations at Portsmouth, England), the young mine experts are well grounded in a thorough knowledge of electrical science.



Effect of Countermining, with Electrically Controlled Submarine Mines.

ELECTRICAL EQUIPMENT FOR CORNWALL CANAL.[1]

BY F. H. LEONARD, JR.

The electrical equipment for the Cornwall Canal is supplied with current from the power-house of Mr. M. P. Davis, near Mille Roches, on the Cornwall Canal. Messrs. T. Pringle & Son were the engineers and the electrical equipment was installed under the personal supervision of the writer.

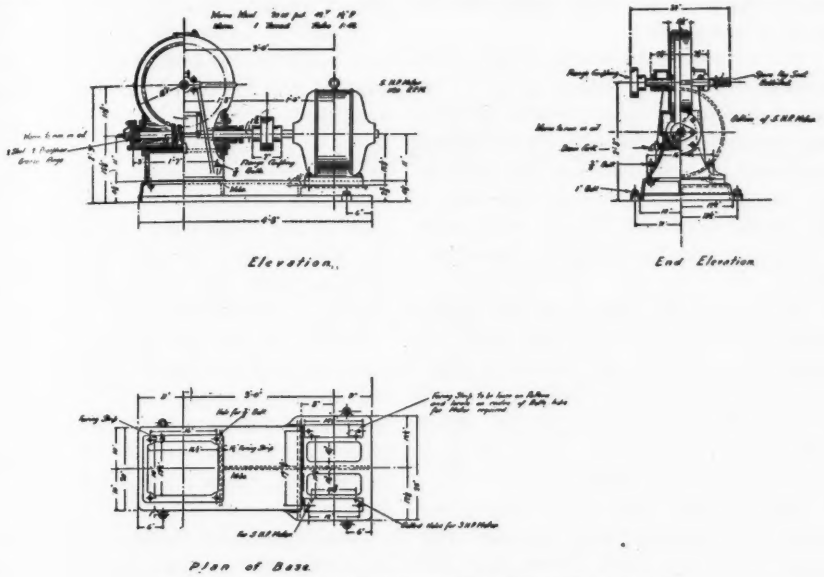


FIG. 1.—ELECTRICAL EQUIPMENT FOR CORNWALL CANAL.

We have fully described the hydraulic and generating equipment for this plant in the *Canadian Engineer* and in the *Electrical World and Engineer*, but to obtain a comprehensive grasp of the complete plant we will again recite some of the particular features in connection with it.

The plant is situated just below the lower dam on the Cornwall Canal, near the village of Mille Roches, and takes water from the upper level, which is an artificial lake made by the construction of a dam across the former river-bed. The tail water empties into the old river-bed which was left dry—except at certain seasons of high water—by the construction of this dam. There is obtained by this means a head, under ordinary circumstances, of about thirty feet, but on account of high back water the plant was designed for operation temporarily on a minimum head of eighteen feet.

The intake is short and cut at about right angles to the weir channel at the south end of the dam built to take care of the overflow from the upper level.

The fine racks and stop log checks are built in one frame of structural steel in front of the entrance to the concrete wheel chambers. Besides the stop logs, head-gates are provided opening in two halves by means of worm-geared head-gate winches. Two large manholes over the centre of each pair of wheels provide for access to the wheel chambers and are large enough to pass the runners through in case of repairs.

The power-house partly covers the wheel chambers, the concrete top of which makes a portion of the switchboard gallery, which is widened at the centre by a platform extending three feet beyond the face of the bulkhead wall.

The power-house foundation rests on the solid rock, the wheel pit being excavated to a depth of about ten feet below the surface of the bed-rock. The arches over the wheel pit are of concrete but faced on the outside with rough picked masonry of large dimensions, which gives to the entire structure a very substantial appearance. The power-house is constructed on a steel frame having brick walls and heavy plank roof.

A hand-power crane of twenty-five-ton capacity with two trolleys having a span of thirty-eight feet is provided for erecting and handling the machinery.

Provision was made for four hydraulic units, giving an ultimate capacity of approximately 6,000 horse-power. Each unit consists of five thirty-five-inch new Sampson wheels by William Hamilton & Company, with horizontal shafts directly coupled to a 1,000-kilowatt Bullock generator operating at 2,200 volts at 180 revolutions per minute and sixty cycles.

The switchboard gallery is about nineteen feet above the main floor of the power-house and accessible by means of a flight of iron steps in the centre and two iron ladders at either end of the power-house.

At present but one unit is installed with two fifty-kilowatt exciters running at 285 revolutions per minute. Switchboard panels are provided for the control of the generators, exciters and the various feeders.

The arc lights, of which 225 are located along the bank of the canal, were furnished by the General Incandescent Arc Light Company, of New York. A three-panel switchboard controls the operation of these lamps and each circuit is regulated by a 100-light G. I. regulator, capable of maintaining practically constant current with any number of lamps in circuit from 1 to 100—its full capacity.

The current for these circuits is stepped up from 2,200 volts by means of transformers of sixty kilowatts each—the transformers being provided with intermediate taps so that besides the full voltage of 11,000 volts, if a smaller number of lamps are required, either 4,400 or 6,600 volts can be used, thus reducing the reactance necessary to maintain a proper

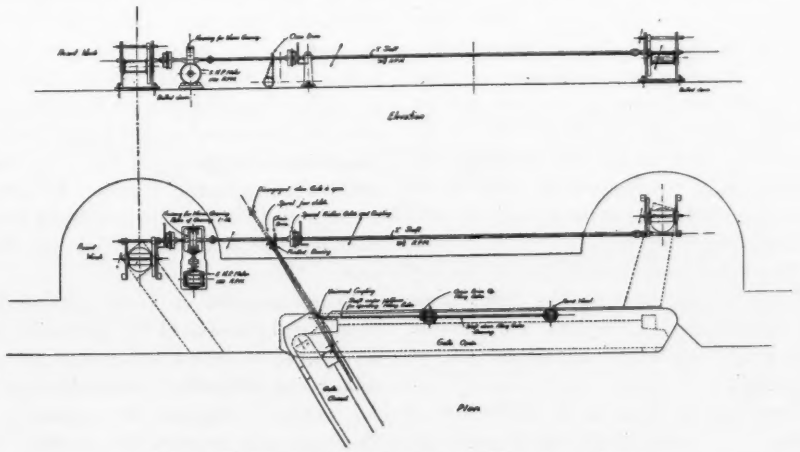


FIG. 2.—ELECTRICAL EQUIPMENT FOR CORNWALL CANAL.

[1] Read before the electrical section, Canadian Society of Civil Engineers, March 24, 1904.

voltage and permitting of a higher power-factor under the conditions of partial load.

Current for the power circuits, three in number, is obtained by stepping up from the generating voltage to 11,000 volts by means of three 150-kilowatt transformers which supply the three-phase transmission lines reaching various locks along the eleven miles of canal.

The primaries of both arc lighting and power transformers are controlled by oil switches connected to the bus-bars on the main switchboard, a separate panel being provided for each class of service. The power circuits are passed through a separate high-potential switchboard which connects the transformers to the three separate three-phase power lines. A 2,200-volt line also provides Mille Roches with light and power service.

Lightning arresters and choke coils are provided for the various circuits. The wiring of the station between the generator and switchboards to the wire tower, from which the circuits are fanned out to different pole lines, is all carried in three conductor cables, lead-encased, suitable trenches being provided in the concrete floors allowing ample space for additional cables.

The pole lines for the lighting and power circuits are of substantial structure, an exceedingly straight lot of cedar poles being used. These range from thirty to fifty feet in height, none having less than seven-inch tops on which are mounted special cross-arms provided with hickory pins which were boiled in steric acid. Five and one-half-inch triple petticoat glass insulators being used with satisfactory results with the 11,000-volt circuits. Bare copper conductor is used spaced sixteen inches on centres, and on account of the low current per line no attempt was made to use the triangular arrangement of conductors, the three wires of each circuit being arranged side by side without transposition.

The three-phase power circuits occupy the upper arms and on the lower arms are located the single-phase arc circuits. The main lines occupy the south bank of the canal.

Crossings are made at the Mille Roches bridge in armored paper cables, one for three-phase 2,200-volt power and lighting circuits and another for the single-phase 11,000-volt arc circuit. Another crossing is made at lock 18, which provides for three-phase power circuit, as well as another 11,000-volt arc circuit to provide for power and lighting on the north bank below this point.

At the Stormont bridge, near Cornwall, another 11,000-volt arc cable provides for lighting the two piers at the bridge and an emergency cable is laid just above lock 17 so that in case of accident to any of the other crossings or a break in the line, emergency connection can be made in the houses covering the cable heads on the bank of the canal.

While in some cases sawed octagon poles have been used for a similar purpose, yet the shaved cedar poles selected in this case present an exceptionally pleasing appearance. Extreme care has been taken in locating and setting out the line and a transit has been used for the work, making the alignment and location almost perfect.

The line is well guyed on the curves with galvanized signal strand, well anchored, or in some cases tied to a heavy guy stub. On the sharp curves, poles are double armed to provide for the severe strain.

LIGHTING.

The lighting of the canal is carried out in a very liberal manner, an arc lamp being located on every fourth pole and the poles averaging about one hundred feet apart. At the locks, as many as twelve or fourteen lamps are located so as to brilliantly illuminate both ends of the locks, as well as the intervening space and the regulating weirs—most of which are located beside the locks.

The lamps are hung from iron-pipe brackets which pass through the pole and are held in place by a collar at the front side and a lock nut at the back and braced on the under side by an iron-pipe strut fastened to the face of the pole by two lag screws. An insulated hanger is used at the outer end of the bracket (two feet six inches from the pole) which, together with the insulators on the lamps, renders danger from grounding in the lamp frame and bracket extremely remote. The lamps are trimmed from the pole without lowering; pole steps are driven in each lamp pole.

Loops are cut in from transposition insulators by means of No. 8 flexible rubber-covered conductor soldered to the bare copper line conductors, particular care being taken to support the connection at the lamp so as to avoid any possible danger of the swing of the lamp causing a break at the binding-post. Some trouble of this character was at first experienced, but was soon overcome by the above provision.

At the lower end of the canal, where three sets of locks are grouped together, the illumination is very brilliant, and viewed from the Stormont bridge at Cornwall—taking in at a single glance some sixty arc lamps reflected in the still waters of the canal—the sight is most impressive in its quiet brilliancy.

A description of the illumination of one of the locks will convey a very clear idea of them all.

A light is located at the piers as the lock is approached from below, and an arc lamp is also located at each side of the lock just below the gate; two more lamps are located at the middle of each lock and two at the upper end of the lock just at the lock gates. There are also two more at the upper piers and as two locks are located side by side, it is easy to imagine that the illumination would almost rival daylight.

Below lock 18 both banks are illuminated all the way by lamps located 400 feet apart. Above lock 18 the lamps are located on the south side of the canal only, with the exception of prominent points, bridges, etc., where lamps are provided on both sides.

The upper level broadens into a lake of considerable proportions, about thirty feet deep near the lower end; the dam retains the water between Sheik's Island and the Canadian shore, making a broad and easily navigable waterway of about three miles to the upper dam. The lamps are here less frequently located on the prominent points on the south side until the upper dam is reached when the canal again narrows to the usual dimensions.

The lamps are again located about four hundred feet apart on the south bank up to lock 21, which is a guard lock, there being very little difference between the upper canal level and the St. Lawrence river at this point. On the long pier on the south side protecting the canal entrance lamps are placed, as well as on the north bank as far up as Dickinson's Landing.

An illumination so perfect as above described, makes navigation as easy at night as in daylight and lockages are performed as rapidly and as easily as they could be in the daytime.

At the upper end of each lock on the south bank there is located a small switchboard cabin, seven feet by nine feet; on the little island between the two locks is located another switchboard cabin and at the upper end of the lock on the north side of the second lock is another cabin.

In the first of those above mentioned are placed three transformers connecting to the 11,000-volt mains, which step the voltage from the line pressure to 550 volts, and it is at this pressure that the

motors operate. A high-tension fuse-board is provided to take care of the primary connections to the transformers. The long enclosed fuse has friction contacts at either end and by pulling these fuses out of the end clips by means of a wooden stick with a hook at the end, the circuit can be opened in case of tempo-

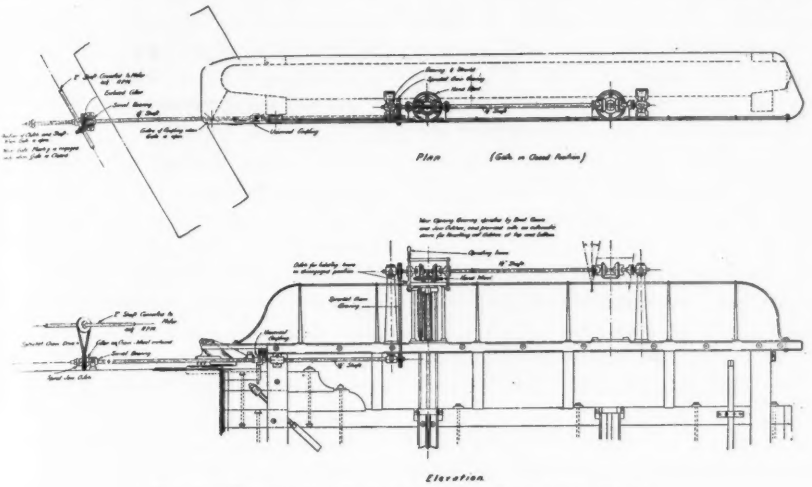


FIG. 3.—ELECTRICAL EQUIPMENT FOR CORNWALL CANAL.

rary trouble, or for any purpose when it becomes necessary to disconnect the transformers. The secondary of the transformers passes through the switch on the switchboards which distributes the secondary current to the motors, two of which are located on each side of the lock. Armored cable with paper insulation is used to conduct the current from the switch cabin to the motors located on the same side of the lock.

The connection for motors on the opposite side is carried through armored cable which leads down through the floor of the switch cabin and passes through a hole drilled in the stone coping of the lock to the upper stop log check—there being two checks cut in the masonry. This leaves one which could be utilized for stop logs in case it ever became necessary to keep the water out of the lock during repairs. The cable turns over a radius of sixteen inches at the top and passes down the check, being protected by a piece of oak plank which is grooved in the centre to take the cable, the plank being fastened by drift bolts to the stonework and protected at the edges with iron strips. As the plank does not come above the edges of the check in the stonework, there is practically no danger of the cables ever being injured by a boat in entering or leaving the locks.

Where the cable crosses on the lock bottom a timber is held on top grooved on the bottom side to receive the cable, and as the top of this timber is well below the breast wall at the entrance of the lock, there is no danger of the cable ever being disturbed.

Rising on the opposite side of the lock is the stop log check, the cable again passes through a hole drilled in the stone coping until it comes out of the earth back of the masonry under the next switch cabin; from this switch cabin the cable is carried into the third switch cabin on the north side of the old locks.

You will bear in mind that the new locks were built on the south side of the old locks, and are about seventy feet longer, the old locks being fifty-five feet wide and 200 feet long inside the gates and the new locks forty-five feet wide and 270 feet long inside the gates and fourteen feet over sills.

On the switchboards in each of the cabins are placed the motor-starting switches connected to autostarters which control the motors on one side of each lock. From the switch cabin on the south side are operated two motors, the first motor being connected by armored cable reaching from the switch cabin underground to the first motor. The second motor is reached by conductors running from the switch cabin overhead to a pole very near the motor at the lower end of the lock, armored cable connecting from the pole underground as far as the masonry and checked into the masonry where it passes over to the motor.

The switch cabin on the little island between the two locks controls the two motors on the north side of the new locks and two motors on the south side of the old locks. The third switch cabin controls the motors on the north side of the old locks, as well as the motor operating the weir-gate mechanism.

The arrangement is identical in all the locks with the exception of No. 15 and old lock 16, which are not provided with weir gates.

The equipment for operating the lock gates and weirs was adapted for use in connection with the winches and weir-gate mechanism already installed without disturbing their capability for hand operation should occasion require.

When these devices were operated by hand, the lockmen laboriously turned a crank on the winches at the two opposite sides of the lock gates, utilizing one winch for opening and the other for closing the gates. Four winches were located at each end of the lock, two on each side, one of which handled the chain to close the opposite gate, the other to open the gate on the side at which these winches were located.

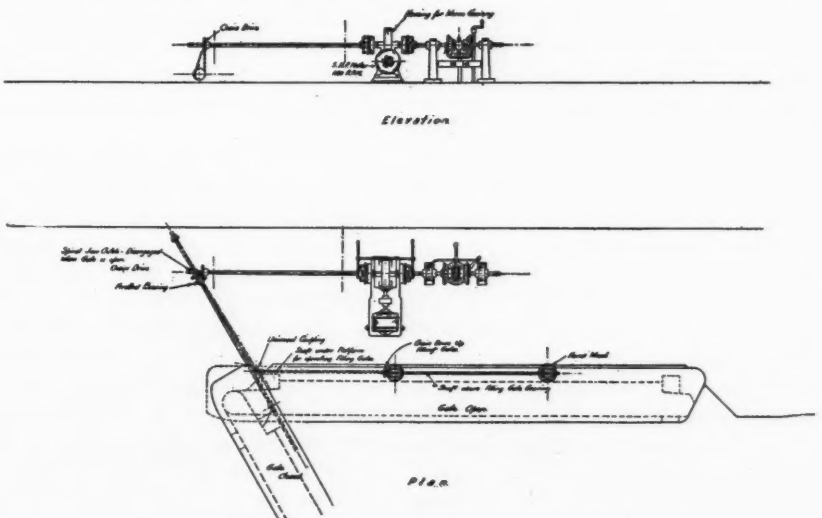


FIG. 4.—ELECTRICAL EQUIPMENT FOR CORNWALL CANAL.

Across the top of each gate is a bridge on which is mounted the worms and rods for opening the two valves in each of the

gates when required to fill or empty the lock.

The electrical equipment utilized practically all this machinery, as it stood with only the necessary changes to make the mechanical connections with the electrical drive.

In order to keep the speed down to approximately what was obtained by hand operation, a very material reduction in motor speeds was necessary. To obtain this and cover the other points, special apparatus was devised and patented by Mr. Alex. Pringle and the writer, which are shown in the drawings attached.

The motors selected were all of five horse-power for both the lock gates and weir mechanism. Some question as to whether a three or five-horse-power motor should be adopted arose, but the matter was decided in favor of the five-horse-power motor on account of its lower speed, and while the capacity of this motor is never exceeded except for a few seconds, the balance of the time running considerably under load, yet the whole arrangement is simple and while somewhat stronger than absolutely required, the interchangeability and greater durability it was thought justified the slight additional expense.

To operate the two winding winches which control the chains for opening and closing the gates, one motor is located near the hollow coin at the heel of the lock gate, which is coupled by means of short length of shafting and friction clutch coupling to the winch near this point, and by means of another friction clutch and length of shaft sufficient to reach the other winch, supported at intermediate points by pedestals carrying journal boxes mounted on cut-stone blocks jointed to the coping, making a practically continuous stone foundation for the mechanism.

The arrangement of the motor-bed, gearing and speed reduction will be more clearly understood by referring to the drawing showing the casing for the worm gear and motor-bed.

As there is a reduction of about forty-two to one, which gives a speed of about twenty-six revolutions for the operating shaft, it was decided to use the worm gear rather than a more complicated triple reduction by means of spur gears. A subbase extends under the motor and also carries the casing for the worm and worm gear. The worm runs in oil, the thrust being taken up by alternate steel and bronze collars and thrust discs, adjustable at one end by means of set screws and check nut to compensate for wear.

The motor, which runs at 1,200 revolutions per minute, is coupled directly to the worm-shaft, the worm being cut out of solid steel and meshing into a hobbed bronze wheel turning on a shaft mounted on babbitted bearings. The projection at one end of this shaft having mounted upon it the friction coupling controlled the working shafts. The opposite end being coupled to a short length of shaft which carries a chain wheel similar to a sheave in a chain hoist and from this point by means of a welded link chain made endless is turned at an angle to the main working shaft, the supplementary shaft for operating the valves in the lock gates. This shaft is supported on bearings secured to the coping of the lock and placed about one-half inch above its surface and continued under the bridge on the lock gate, a universal coupling being utilized at a point near the gate pivot so that the travel of this joint is minimized.

The arc of the circle through which this coupling passes is provided for by a swivel box containing the end of the driven shaft, and the travel in and out is allowed for by having the chain sheave run free on the shaft except when engaged by a jaw clutch keyed to the shaft so as to allow the shaft to run in and out as it passes through this arc and engage or disengage the clutch at the proper time for controlling the valve mechanism. The clutch being disengaged, allowed the driving sheave to run loose on the shaft, the shaft itself remaining idle during the time the gate is open and is only put into operation when the gate is swung to the closed position.

The valves are operated by bevel gear reversing mechanism, which allows the operator to either close or open the valves in the gates by throwing the shipping lever which engages a jaw clutch with one of the bevels required to operate the valve stem in the desired direction. The travel of this stem, however, is limited by an automatic stop consisting of a loop and bell crank operated by a pin in the cross-head traveling with the valve system, so that at the lower or upper limit of travel the pin trips the bell crank connecting with the shipping lever so as to throw the clutch out of engagement with the bevel gear which produces the motion. This mechanism permits of much more rapid lockage than could be carried out by hand and reduces the necessary force of lockmen to one-half the crew formerly required.

LOCKAGES.

While the usual lockage is, perhaps, a familiar sight, many possibly do not understand it, and a short description will not be out of place.

Let it be assumed that a barge is proceeding up the canal, following another which has previously passed in the same direction.

The lock would, of course, be full of water up to the level of the section above. As the barge approaches the lock the lockmaster starts the motors at the lower end by means of the starting switch on the switchboard in the lock house, and two of the lockmen proceed to the lower gate and open the valves, which allows the lock to empty into the lower reach; the mechanism is started on all four valves one after the other. One of the lockmen crosses to the south side and the other to the north side. The mechanism operating the valve stems continues to operate until the valves are wide open and the pin trips the operating mechanism, leaving the valves in this condition until the water within the lock has reached approximately the level of the lower reach.

The lockmen on each side of the canal then throw in the friction clutch which connects by means of a short shaft to the pinion meshing into the large spur wheel on the winch. This winds up the slack on the chain which runs through the chain well over a roller and out to a hook about four feet above the sill at the outer end of the lock gate.

As soon as the slack is wound up, the chain commences to move the gate, opening it until it leaves the passage free for the entrance of the barge into the lock. As soon as the boat is moved into position and made fast, the gate is closed by throwing in the opposite clutch which operates the winch at the opposite end of the shaft and closes the gate—the clutch on the first winch being released, of course, allows the chain to pay out as quickly as required to permit the gate to close.

As soon as the gates are closed, the clutch operating the shaft which drives the valve mechanism has moved into engagement and starts the valve-driving mechanism, the lockmen throw the lever starting the two valves in each of the lock gates to close and immediately walk over to the other end of the lock; before they reach it, however, these valves have closed and the tripping mechanism has thrown the clutch out of gear. The valves in the gates in the upper end of the lock are then opened in a manner similar to that described in connection with the opening of the lower gates, allowing the barge to proceed on its journey.

WEIRS.

To keep the various levels of the canal normal, on account of excessive flow of water from above or any heavy draught of power used on a level or by lockages, the flow of water has to be compensated for by adjusting the weir gates.

These gates are operated by worm and

segment, or, in some cases, by raising or lowering the valves in a manner similar to that on the lock gates, the operating of which is carried out in much the same way as described in connection with the gates.

As there are a number of weir gates or valves which must be capable of independent operation, provision is made by means of a double jaw clutch engaging with either one or the other of two beveled gears on a horizontal shaft which meshes into a third beveled gear on a shaft of the worm for operating the segment which drives the valve stems.

The operator only has to throw the clutch into engagement so as to move the valve in the desired direction and as soon as the gate has opened or closed sufficiently for the purpose of regulation the lever is thrown out of engagement with the gear. A friction clutch is placed between the shaft of the worm wheel driven by the motor so that in case of accident resulting in jamming any of the parts, the friction clutch will slip before any serious breakage occurs.

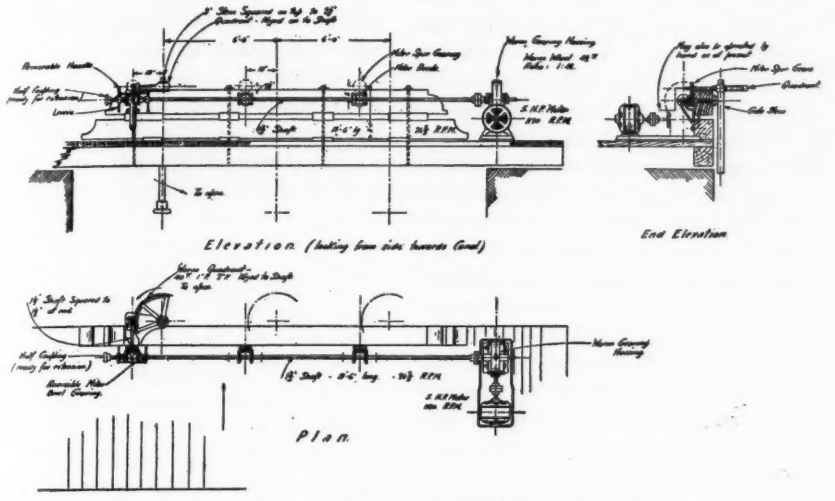


FIG. 5.—ELECTRICAL EQUIPMENT FOR CORNWALL CANAL.

BRIDGES.

The equipment for the bridges is operated by a motor driving the mechanism through worm gears, the same power unit being utilized as for the operation of the lock gates and weirs, an extension of the interchangeable idea. Aside from the first speed reduction, however, the gearing is quite different, though in the case of both the Mille Roches and the Stormont bridges the arrangement is worked out on similar lines.

The bridge at Mille Roches is 179 by 12 and has the motor swung under the bridge just outside of the turn-table, being counter-balanced by weights at the opposite end of the bridge. I-beams support the motor and worm-gear case the shaft of which drives the gearing communicating the motion to a pinion meshing with the rack which turns the bridge.

A friction clutch communicates the power from the motor-driven worm shaft to one or the other of a pair of bevels turning the bridge in whichever direction the operator desires. The clutches are operated by two removable levers coming up through the bridge floor so that the bridge tender has ready control of both.

To swing the bridge, the operator first starts the motor, then throws the lever which withdraws the bolts unlocking the bridge. One of the clutch levers is then operated so as to engage the bevel gear required to turn the bridge in the desired direction for opening. The friction slips for a while until it gets the bridge under motion, then it swings rapidly until it is nearly open when the operator uses the other friction clutch (which tends to turn the bridge in the opposite direction) as a brake to retard the speed and gradually bringing the bridge to rest in the open position.

The reverse motion is used for closing and is operated in very much the same way.

The control of the Stormont bridge is very similar to that of the Mille Roches bridge, the only difference in the mechanism being that the power unit is mounted inside the drum of the turn-table on I-beam frame, which does not require to be balanced.

The power is communicated with a large intermediate gear so as to reach the gearing originally utilized in turning the bridge by hand.

The Stormont bridge is very much heavier than the Mille Roches bridge, but the operation is very satisfactory. The normal full-load current is only exceeded for a few seconds in starting.

As in both cases, the motors are mounted under the deck of the bridge, little protection is required, but a galvanized iron cover is provided so that drip from the underside of the planking is prevented from reaching the motors. The motors alongside the locks are also protected with easily removable galvanized iron hoods or covers. This is the only protection from the weather which has been provided for the motors, and they have been left in their position without any other cover for the last two winters.

The hardiness of the motor used has been well demonstrated by the fact that the motors start up every season without any trouble. The only serious trouble with the machines occurred after a heavy storm which brought the 11,000-volt primaries in contact with the 550-volt secondaries for a few seconds, resulting in a burnout of half a dozen motor coils in one of the machines. Lightning has occasionally given slight trouble but nothing of a very serious character has occurred.

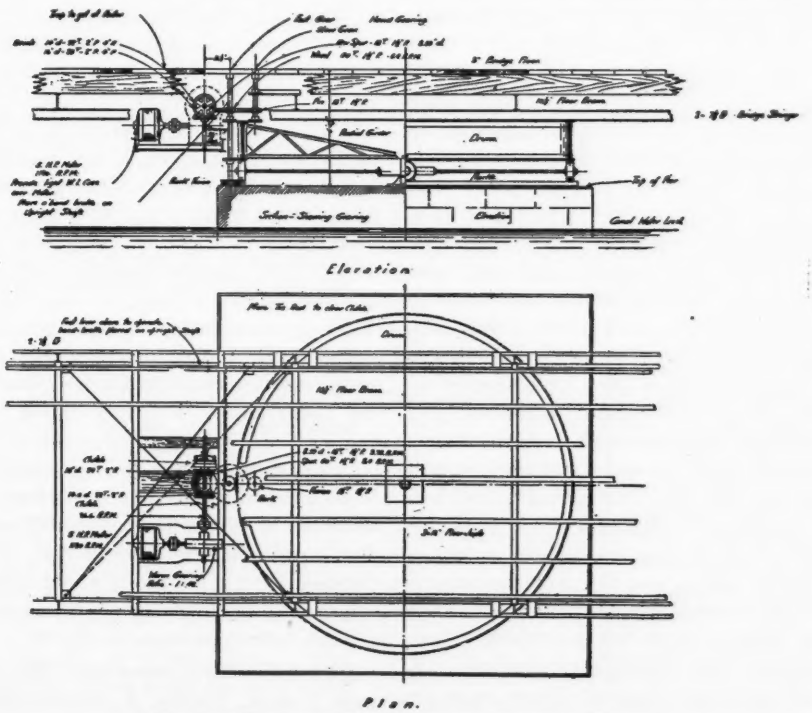


FIG. 6.—ELECTRICAL EQUIPMENT FOR CORNWALL CANAL.

Electrical Notes from Europe.

By Our Special Correspondent.

AERIAL telegraphy is now making considerable progress in France. The secretary of posts and telegraphs decided not long ago to erect two aerial telegraph stations in the neighborhood of Paris. These stations have now been built and equipped with the most recent apparatus, and they have already commenced to operate. One of the stations is placed at Villejuif, in the suburbs, and the other at Melun, at twenty miles from the city. These two posts are to be used mainly for experimental purposes, and are designed to train the technical staff and the operators which will be needed in the future for the stations to be erected along the coast of France, for the government has an extensive coast system in view. Different forms of apparatus and new inventions will be tested here before being finally adopted. At the Villejuif station the current is furnished by a dynamo driven by a gasoline motor and charging a set of accumulators. The Melun plant uses current from the central station mains. The apparatus of both stations has been designed by M. Rochefort and constructed by the Mors Company. As soon as the preliminary tests are made at the two trial stations, it is expected to install the different aerial telegraphy posts along the coast. These will be used to communicate with vessels, both for the marine department and for public use. Up to the present there have been no stations for the public messages, as those which now exist are used exclusively by the marine for signaling to the warships. An agreement was made last year, however, by which the minister of war is to turn over these stations to the postal and telegraph department, and the latter is to operate them in the future, as well as all the new stations which will be erected. The coast system which will be eventually established is to serve for the use of the war department as well as for the public. In this way the government expects to gain a decided advantage by using a single system instead of two separate ones, which might conflict with each other and besides would be more expensive to operate. The first station to be opened to the public will no doubt be those of Ouessant, on the channel coast, and a second at Porqueralles, and these are to be increased in capacity. The administration is now studying a project of erecting several other stations on the coast in the immediate future. One will no doubt be placed at the Cape of La Hague on the north coast, a second at La Combre and a third in Corsica, at Ajaccio. As to the apparatus which is now used on the warships, considerable progress has now been made in the distance which can be covered and according to reports the French vessels are breaking all the previous records for distance. The journals state that the foreign warships are not able to signal at greater distances than 115 miles, according to the statements of English and Italian officers. The French battleship Jena, of the Mediterranean squadron, and the cruiser Guichen, of the Atlantic fleet, are able to receive messages at a distance of 195 miles. This result has been considered a record in Europe, but according to the latest news the distance has been still further increased. Not long ago the battleship St. Louis while in the Mediterranean received telegrams sent from Port Vendres on the south coast at a distance of 273 miles. A few weeks before this, while lying in the harbor of Barcelona, the St. Louis took messages which were sent from the battleship Suffren while in the harbor of Toulon, covering a distance of 223 miles.

Another series of experiments is now being carried out in Paris, and the Eiffel Tower is to be used as the central point. This should make a specially good station owing to the great height of the tower. The metallic structure will not, however, be used to form the mast, but it will support a cable or copper wire 350 metres long. At the ground the wire passes into the cabin which is to contain the instruments. With the station thus equipped, and a heavy current which can be taken directly from the city mains, it is expected to signal over the country to distances of two or three hundred miles. The experiments are being carried out by Captain Ferries, of the city engineering corps, aided by the telegraph personnel.

In a paper lately presented to the German Physical Society, J. Sprecht determines the heat given off by radium salts. He used an ice calorimeter, with thirty-four milligrammes of radium bromide contained in a sealed tube. The determination was carried out with greater exactness than heretofore, and he finds that one gramme of the salt would give off heat equivalent to 61.15 calories per hour. According to the formula for the radium bromide ($RaBr_2$) and the atomic weight of radium which is known to be 258, he calculates that one gramme of metallic radium would give off 98.83 calories per hour. According to this figure, a quantity of radium equal to 6.4 kilogrammes would represent one horse-power in heat, and this is given off, as is well known, in a continuous manner, which is one of the most remarkable properties of the new body.

The Swiss government is taking an active interest in the question of electric traction on the main railroad lines. This is proved by the fact that a committee of delegates, representing the different interests, made a visit not long ago to the trial plant which the Oerlikon Company installed for making experiments upon electric traction on standard gauge lines. Following this will come a series of trials on a large scale, which have been projected for the Seeback-Wettigen line, one of the state railroads. On the trial road the Oerlikon Company used an electric locomotive which was built for 400 horse-power. It is supplied directly with current at 1,500 volts, monophase. The locomotive represents the most recent ideas along this line and will realize an important progress, both in the direct use of high-tension current and again in the use of monophase alternating current. The locomotive can draw a freight train (on a level grade) of 500 tons, made up of thirty loaded cars, at an average speed of twenty-five miles an hour. It can carry this out continuously and takes a current of but thirty-seven amperes. This, however, corresponds to a considerable power, owing to the high voltage which is used. To take the current from the overhead line to the motors, a new form of trolley, or rather moving contact, has been designed. The method of fixing the wire differs from the usual practice. Instead of being suspended or placed on side brackets, it is mounted directly on insulators which are carried on the top of the posts and lying outside the limits of the traction line. The wire lies at a height of sixteen feet from the ground. The new contact follows the wire closely and it is claimed that there is no sparking. It is of solid construction and occupies but little space. The frame which fixes the contact piece to the car is made up of metal tubes and weighs but 3.3 pounds.

A new method of soldering aluminum has been found which is intended to overcome the well-known difficulties in soldering this metal. The solder is made up of five parts aluminum, five of antimony and ninety of zinc. If more antimony is added to replace the zinc, the solder becomes harder. To make the solder, the aluminum is first melted and then the zinc is added gradually. When the latter is all melted the antimony is next added. The solder is then cast into sticks as usual. The two surfaces to be joined are well cleaned and then entirely covered with solder, which is made to penetrate well into the metallic surfaces. The parts are then pressed together and heated to a high point in a soldering lamp. The new method is said to give a solid and strong joint.

Five of the seven wireless telegraphy stations of Italy will shortly be opened for public messages. Up to the present these have been used exclusively by the government, but the minister of the marine recently made an agreement with Marconi regarding the above change, and the public will now have an opportunity to make use of the stations. Two stations have been reserved exclusively for the government, one of these is the Monte Mario station of Rome and the other is in Sardinia. As many as eight new stations will be soon completed, and it is expected that they will be in operation in the latter part of the year. One of these lies near Venice and another is located in Sardinia. They are expected to work over a radius of 200 miles. Besides these stations is the post in the naval academy at Leghorn, also the San Vito and the Varignano stations near Spezzia which are controlled by the navy department. It is stated that the tariff for the public messages which will be sent and received at the coast stations is 7.50 lire ($1.50) for a message of twelve words.

An extensive motor plant has been lately installed in the Baker oil district. Motors are now used instead of steam engines for drilling the wells and performing other operations. The plant has been equipped by the Allgemeine Company, of Berlin. The region which is supplied with current by the new central station lies to the north of the town of Baker, which is the largest commercial centre in the Caspian district and well known as a centre of petroleum production. There are at present over 2,000 wells in the region, which give an annual yield of twelve million tons. To furnish current for the motors, a large central station has been erected. The boiler house contains four tubular boilers of the Steinmüller pattern. Petroleum residues are used as fuel and these are fed into the grates from two large tanks. The dynamo room contains two engines of the Collmann horizontal pattern, giving 750 horse-power each and working at eighty revolutions per minute. Each engine drives an alternator of the three-phase type built by the Allgemeine Company. These machines work at 100 cycles and deliver 750 kilowatts each. The voltage is 6,500, and is used directly on the high-tension transmission line. The latter runs overhead and the three wires are brought over a distance of ten miles to a cable tower. From the tower a set of underground cables leads to the substations. At present there are two of these, while a third station is soon to be erected. Each is provided with three triphase transformers which lower the voltage from 6,000 to 1,000 volts. The wires from the substations to the motors are carried overhead on poles. The motors are used for boring the wells as well as for pumping, etc., and some of the wells run to 1,700 feet depth. Steam engines were formerly used, and as the boilers were at some distance off the steam piping sometimes reached 600 or 700 feet in length, which gave a great loss of steam at the joints. The electric motor system has proved much more economical as well as easier to operate. Each well is equipped with a motor which gives from twenty-five to sixty horse-power. The motors use 1,000 volts direct from the line. In order to prevent accidents from fire, which occurred at first from the sparking of the motors, the latter are now placed in stone cabins and well protected.

A successful hydraulic plant in the Tyrol is the new station of Zwolfmalgreien, which is equipped for 2,000 horse-power. The outfit has been supplied by the Oerlikon Company, using three-phase alternators. A 3,600-volt overhead and underground line passes to the towns of Bozen and Gries. The transformer posts which have been placed here lower the voltage for the secondary mains. The hydraulic power is furnished by the Eggenthalerbach, and the dam is located about two miles above the station. The water is brought in an underground canal for a distance of 3,400 metres. This conduit is connected to the penstock which leads for 416 metres to the station, with a fall of 208 metres. The dynamo room contains five direct-connected turbine groups which give a total of 2,500 horse-power. These machines use a net output of 226 litres per second, and deliver 500 horse-power each. They operate at 500 revolutions per minute, and give 3,600 volts at fifty cycles. Two high-tension lines start from the station. The reducing transformers in the towns are placed in cylindrical kiosks about twenty feet high. These receive the underground cables, and current for the city mains at the reduced voltage comes out at the top.

Among the new electric lines may be mentioned the road which is now in operation between Tabor and Bechyn, Austria. The length of the line is about fifteen miles and it uses a high-voltage system directly upon the motors of the cars, with a voltage of 1,400. Distribution is carried out on the three-wire system, using two overhead wires and a rail return. The motor cars are equipped with four motors of thirty kilowatts each, with a motor mounted upon each axle. The present method of coupling is to connect the four motors in series of two each, which works reasonably well at present, but in the next set of equipments it is thought preferable to use but two driving axles on the car and mount two motors an each axle. The two motors of a pair will then run at the same speed which will give an equal distribution of the load. Current for the line is supplied from an independent central station near Tabor. The plant contains three engines of 150 horse-power and a large battery of accumulators which works in parallel with the machines for taking up the load of the traction system.

The electrical enterprises of Japan are numerous and besides there is a considerable number of new projects which will no doubt be carried out in the near future. One of the largest plants of Japan is the central station of Tokio, which supplies current for the city lighting as well as for motors. At present the station is equipped with machines to the extent of 5,000 horse-power, but an increase is soon to be made which will bring the capacity up to 8,700 horse-power. A marked increase in the consumption of current, especially for lighting, is noticed at present, and each month sees a considerable addition to the list of subscribers. On this account it is probable that a further increase of the station will soon be necessary, and it will no doubt reach a capacity of 10,000 horse-power before long. The municipal authorities of Tokio are now considering a project for establishing an extensive system of electric traction in the city and suburbs, and if this is carried out a number of new generators will be placed in the station. As to electric plants in other regions of Japan, a new hydraulic station is to be erected on the river Tama. It will supply current for lighting and power of three towns of considerable size in the neighboring district, and will be equipped to furnish 10,000 horse-power. Another installation is a twenty-mile electric road which will run between the towns of Kanavaga and Shinavaga. The city of Osaka is considering a project for a complete system of traction lines which are to be operated by the municipality.

C. L. DURAND.

Paris, May 26.

THE SINGLE-PHASE INDUCTION MOTOR.[1]

BY WILLIAM S. FRANKLIN.

Fig. 1 represents a rotor having Z conductors, surrounded by a stator having a two-pole winding of N conductors spread over two opposite arcs, each of ninety degrees span. Each rotor conductor is supposed to be short-circuited through the conductor lying opposite to it, so that the rotor presents $\frac{Z}{2}$ independent circuits, each of resistance R. In case the rotor conductors are short-circuited by end rings, as in the squirrel-cage rotor, it is an easy matter, knowing the resistance of each rotor conductor and the resistance per unit length of the short-circuiting ring, to calculate the value of R for an equivalent winding of the type here specified.[2]

This rotor, whether standing or running, is magnetically stationary and magnetically equivalent to a rotor such as shown in Fig. 2, having a concentrated winding AA′ of $\frac{Z}{4}$ turns, each of resistance R, and a concentrated winding BB′ of $\frac{Z}{4}$ turns, each of resistance R.[3]

Consider an alternating flux Φ, Fig. 2, stationary in space but harmonically distributed around the periphery of the rotor as it flows into the rotor from the stator, or into the stator from the rotor. Let E_0 be the pressure induced in the N conductors (N/2) turns of the stator winding by this alternating flux and E_z, the pressure which this flux induces in the Z/2 conductors (Z/4) turns of the winding B. Then $E_0/E_1 = 0.901 \times N/Z/2 = 1.802 \times N/Z$, 0.901 being the ratio of the chord to the arc of ninety degrees.[4] Therefore to give a 1:1 ratio of transformation between stator winding and rotor winding B; that is, to make $E_0 = E_1$, we may change the stator winding to give $N = Z \div 1.802$. Along with this change of N we may imagine the value of the supply pressure to be changed in the same ratio, and the sectional area of the wire used in the stator winding to be changed in the inverse ratio. In this way any given single-phase motor with any type of rotor and having a stator winding of any number of turns spread over any arc may be reduced to the equivalent 1:1 arrangement, and therefore the following theory is worked out for this 1:1 arrangement.

It is to be noted that the flux Φ, Fig. 2, which is stationary in space but alternating at a given frequency f induces the same pressure in any winding (distributed or concentrated) as would be induced in the same winding by a flux having a constant value equal to the maximum value of Φ but rotating at a speed equal to the frequency f, provided that the flux is in each case harmonically distributed around the periphery of the rotor. The special use to be made of this fact later is that, from it, we know that the pressure induced in the B winding by pulsations of Φ is to the pressure induced in the A winding by the turning of the rotor through Φ, as the frequency of pulsation of Φ is to the speed of rotation of the rotor.

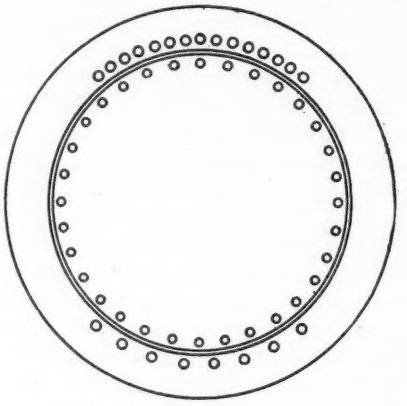


FIG. 1.—SHOWING ROTOR.

It is furthermore to be noted that the windings A and B, Fig. 2, which represent magnetically the actual rotating windings of the rotor, are stationary, and therefore all electromotive forces induced in rotor windings and all rotor currents are to be considered to have the same frequency as the electromotive force applied to the stator windings.[1]

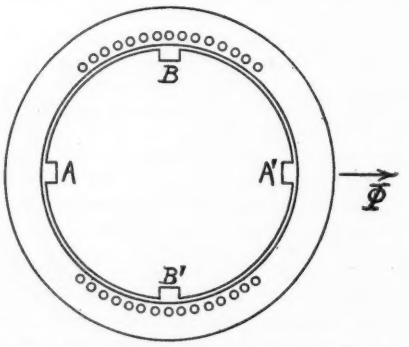


FIG. 2.—ROTOR HAVING CONCENTRATED WINDING.

Fig. 3 represents diagrammatically the stator winding S′ of a single-phase induction motor and the two stationary windings A and B which represent the moving rotor windings at each instant. When a periodic pressure E_0 acts upon any electromagnetic system the electric and magnetic effects produced are of the same periodicity. The most completely general periodic flux through the rotor, Fig. 3, consists of two periodic fluxes Φ and Φ_c, perpendicular to each other in space and of which the phase difference in time may be anything whatever. We assume these periodic fluxes Φ and Φ_c to be harmonic, and we shall develop the theory of the single-phase induction motor upon these fluxes as a basis. We shall call a pressure which is induced by the time variation of a flux a pulsational pressure, and a pressure which is produced by the cutting of flux by motion a rotational pressure.

Notation.

E' = primary impressed pressures.
E_0 = part of primary pressure which is over and above the part used to overcome primary resistance R′ and primary magnetic leakage reactance X.[1]
f = primary frequency.
n = rotor speed.
M = magnetizing current in primary.
I_0 = load current in primary.
I_1 = current in rotor winding A.
I_2 = current in rotor winding B.
R = total resistance of winding A and of winding B.
Z/2 = turns in winding A and turns in winding B.
N = turns in primary winding.

The two fundamental equations of the single-phase induction motor express the following two conditions:

(*a*) That the sum of the rotational pressure in A due to Φ and pulsational pressure in A due to Φ_c shall be equal to RI_1, and

(*b*) That the sum of the rotational pressure in B due to Φ_c and the pulsational pressure in B due to Φ shall be equal to RI_2.

In considering these pulsational pressures and rotational pressures in A and B careful attention must be given to the matter of algebraic signs.

The positive directions of Φ and Φ_c are chosen as represented by the arrows in Fig. 3 and the positive directions around windings A and B are chosen as customary in relation to the positive directions of Φ and Φ_c; that is, the positive direction

[1] A paper presented at the 187th meeting of the American Institute of Electrical Engineers, New York, May 17-18, 1904.

[2] In fact R is equal to the resistance of two conductors of a squirrel-cage winding plus $2/\pi$ times the resistance of an arc of one of the short-circuiting rings of which the length is equal to the diameter of the ring.

[3] This result is reached by integrating the magnetomotive force of Z/2 independent phases of alternating current around the periphery of the motor.

[4] See Franklin and Williamson, pp. 121 to 123.

[1] See Franklin and Williamson, pp. 244 and 245.

[1] When the magnetizing current of a transformer is small compared with load current, primary and secondary currents are nearly in phase, and all magnetic leakage reactance, both primary and secondary, may be located in the primary. See Franklin and Williamson, p. 176.

around A is the direction in which a right-handed screw coaxial with Φ_c would have to be turned to travel in the positive direction of Φ_c and the positive direction around B is the direction in which a right-handed screw coaxial with Φ would have to be turned to travel in the positive direction of Φ. Therefore the positive direction around A is up A and down A′, and the positive direction around B is up B and down B′.

With this choice of signs the pulsational pressure in A due to Φ_c is equal to $2\pi f \frac{Z}{2} \Phi_c/\sqrt{2}$ where Φ_c represents the maximum value of the cross-flux, and this pulsational pressure is ninety degrees behind Φ_c in time phase. Therefore this pulsational pressure in A may be written

$$-j.\frac{\pi f Z \Phi_c}{\sqrt{2}}$$

Similarly the pulsational pressure in B due to Φ is

$$-j.\frac{\pi f Z \Phi}{\sqrt{2}}$$

The rotational pressure in A due to Φ is in phase with Φ and positive when Φ is positive. It is therefore equal to

$$+\frac{2\pi n \frac{Z}{2} \Phi}{\sqrt{2}} \text{ or to } +\frac{\pi n Z \Phi}{\sqrt{2}}$$

The rotational pressure in B due to Φ_c is in phase with Φ_c and negative when Φ_c is positive. Therefore it is equal to

$$\frac{\pi n Z \Phi_c}{\sqrt{2}}$$

Therefore we have the fundamental equations:

$$RI_1 = +\frac{\pi n Z \Phi}{\sqrt{2}} - j.\frac{\pi f Z \Phi_c}{\sqrt{2}} \quad (1)$$

$$RI_2 = -\frac{\pi n Z \Phi_c}{\sqrt{2}} - j.\frac{\pi f Z \Phi}{\sqrt{2}} \quad (2)$$

It is desirable to transform these two fundamental equations so as to eliminate the two quantities Φ and Φ_c. To this end we may write $k I_1$ for $\frac{\pi Z \Phi_c}{\sqrt{2}}$ where k is a constant. This is evident when we consider that the flux Φ_c is produced by the current I_1. Furthermore we may write E_0 for $j.\frac{\pi f Z \Phi}{\sqrt{2}}$ inasmuch as the pulsational pressure in B is opposite to E_0 in phase, and equal to E_0 if we make N equal to $Z/1.80^2$. Therefore equations (1) and (2) become

$$RI_1 = -j.\frac{n E_0}{f} - j k f I_1 \quad (3)$$

$$RI_2 = -k n I_1 - E_0 \quad (4)$$

Now I_1 is wholly a magnetizing current and it is therefore comparatively small in value, so that as a first approximation RI_1 may be placed equal to zero. The effect of RI_1 upon the performance of the motor will be considered later. Therefore equation (3) becomes:

$$o = n E_0 + k f^2 I_1 \quad (5)$$

or

$$I_1 = -\frac{n E_0}{k f} \quad (6)$$

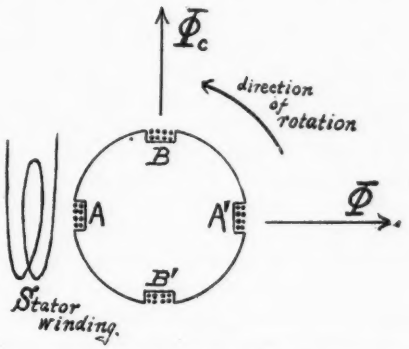


FIG. 3.—SHOWING THE STATOR WINDINGS OF A SINGLE-PHASE INDUCTION MOTOR, AND TWO STATIONARY WINDINGS.

Substituting this value of I_1 in equation (4) and solving for I_2 we have:

$$I_2 = \frac{E_0}{\left(\frac{f^2}{n^2 - f^2}\right) R} \quad (7)$$

or, since $I_0 = -I_2$ we have

$$I_0 = \frac{E_0}{\left(\frac{f^2}{f^2 - n^2}\right) R} \quad (8)$$

which shows that the load current I_0 in the primary may be thought of as being produced by the useful part E_0 of the primary pressure through a fictitious resistance $\left(\frac{f^2}{f^2 - n^2}\right) R$. This fact enables us to apply a modified form of the Heyland[1] diagram to the calculation of the performance curves of the single-phase induction motor.

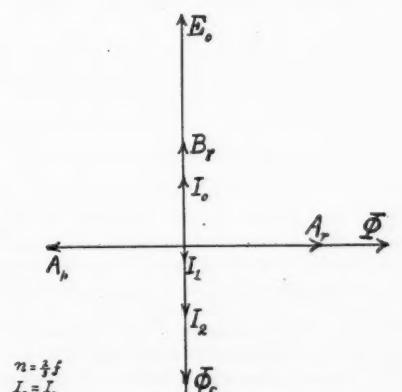


FIG. 4.—PRESSURES CALCULATION.

Before proceeding to this application of the Heyland diagram it is interesting to consider the relation between Φ and Φ_c on the assumption that RI_1 is equal to zero. Upon this assumption equation (1) reduces to:

$$o = n \Phi - j f \Phi_c \quad (9)$$

or

$$\Phi_c = -j.\frac{n}{l}.\Phi \quad (10)$$

which shows that Φ_c is ninety degrees behind Φ in time phase and that the ratio Φ_c/Φ is equal numerically to n/f. Therefore the cross flux Φ_c is zero at standstill, and it is equal to Φ at synchronous speed. Furthermore, at standstill only the simple pulsating flux Φ passes through the rotor, as the rotor speeds up the resultant flux through the rotor becomes an elliptically rotating flux, and when $n = f$ the resultant flux through the rotor becomes a rotating flux of unvarying value exactly as in the polyphase induction motor. Furthermore, the magnetizing current I_1 being proportional to and in phase with Φ_c is ninety degrees behind Φ or 180 degrees behind E_0 in time phase; it is equal to zero at standstill, and it increases in proportion to rotor speed, reaching at synchronism a value sensibly equal to the magnetizing current M in the primary winding.

The action of the single-phase induction motor running at speed n is as follows, magnetic leakage and primary resistance being ignored: the primary pressure acting on the primary winding produces a pulsating flux Φ, Fig. 3, which produces in the primary winding a pulsational pressure sufficient to balance the impressed pressure. This flux Φ produces in winding A, Fig. 3, a rotational pressure A_r, Fig. 4, which produces the magnetizing current I_1, which in turn produces the cross-flux Φ_c and this cross-flux in its turn produces a pulsational pressure A_p in A which is equal and opposite to A_r, RI_1 being negligible. This cross-flux Φ_c produces a rotational pressure B_r in B which opposes the pulsational pressure B_p due to Φ but is considerably less in value, so that the sum of B_r and B_p is an unbalanced pressure in phase with Φ_c and this unbalanced pressure produces a large current I_2 in B. The effect of this current I_2 is to permit the flow of an equal and opposite load current I_0 in the primary coil by virtue of which the primary pressure delivers power to the motor. We shall now proceed to develop the equations of power and torque with the view of applying the Heyland diagram.

The total power delivered to the rotor

[1] See Franklin and Williamson, p. 256.

is delivered to circuit B, Fig. 3, and it is equal to the product of I_2^2 into the fictitious resistance $\left(\frac{f^2}{f^2-n^2}\right)R$. That is:

Total power delivered to rotor =

$$I_2^2 R \left(\frac{f^2}{f^2-n^2}\right) \qquad (11)$$

Furthermore:

Power lost in circuit B as heat $= I_2^2 R$ (12)

The difference between (11) and (12) is the power which is developed by the torque T which is exerted upon rotor circuit B. Therefore this difference must be equal to $2\pi n$ T, so that

$$T = \frac{1}{2\pi} I_2^2 R \left(\frac{n}{f^2-n^2}\right) \qquad (13)$$

This is the equation which will be used in connection with the Heyland diagram, but a better idea of the relation between torque and speed may be obtained by eliminating I_2^2 from (13), using equation (7). This gives:

$$T = \frac{1}{2\pi} \cdot \frac{E_0^2}{R} \cdot \left(\frac{n}{f^2} - \frac{n^3}{f^4}\right) \qquad (14)$$

Therefore, if there is no magnetic leakage so that E_0 may be considered as constant, the torque of a single-phase induction motor is proportional to $\left(n - \frac{n^3}{f^2}\right)$ and the torque is zero at standstill $[n = 0]$, and also at synchronous speed $[n = f]$.

The cross magnetizing current I_1 in so far as it represents loss of power gets its power from the revolving rotor through the action of a back torque, thus lessening the effective torque of the motor or with given motor load causing a slight decrease in speed and a corresponding slight increase in I_2 and in the primary load current I_0 which is in phase with E_0. The power loss represented by I_1 is partly $I_1^2 R$. The eddy current and hysteresis losses are distributed between the primary magnetizing current M and the cross magnetizing current I_1 approximately as follows: at standstill all the core loss is supplied by the power component of M, and at standstill the core loss is large inasmuch as the rotor iron is then the seat of considerable loss. With increasing speed the total eddy current and hysteresis losses decrease and are shared between M and I_1, the part supplied by I_1 being proportional to the speed and equal to half the whole at synchronous speed. Therefore the power component of I_1 increases with increasing speed, while the power component of M decreases with increasing speed, but the increase of power component of I_1 with speed means an increase of load current I_0 which supplies to the rotor the mechanical energy which is delivered to I_1 by back torque due to I_1; and one may think of this slight increase of I_0 as compensating the slight decrease of the power component of M, so that it is permissible to consider the whole of the core losses as supplied by a constant or nearly constant primary magnetizing current, in which case the loss $I_1^2 R$ is the only loss to be associated with the cross magnetizing current I_1.

The cross magnetizing current I_1, in so far as it is wattless, causes a slight pulsating increase and decrease of speed as it takes energy from and gives it back to the revolving rotor. If the moment of inertia of the rotor is large this pulsation of speed is exceedingly small, and in this case the wattless component of I_1 has no effect whatever upon the primary current. It is to be particularly noted that time lag of I_1 behind the rotational pressure due to Φ which produces I_1 does not involve any space lag, so that the magnetomotive force due to I_1 has no component which opposes the flux Φ either when the resistance of winding A is negligibly small or when the resistance of winding A is large In other words the currents produced in the actual rotor windings by the rotational pressure due to Φ are always symmetrically distributed with respect to Φ (no space lag), although the maximum value of these currents may occur later than the instant at which $\frac{d\phi}{dt}$ is equal to zero. The idea of the carrying of the rotor currents around by the moving rotor out of the position in which they would be at standstill, thus creating a cross magnetomotive force, is entirely foreign to the fundamental idea of the magnetic representation of the rotor windings by the stationary windings AA′ and BB′; in fact, the writer believes that this idea of the production of cross magnetomotive force by the carrying of rotor currents around out of opposition to the primary is essentially a wrong idea. The cross magnetizing current I_1 is produced through the mediation of a rotational pressure which is produced in the rotor conductors as they cut the flux Φ as above explained.

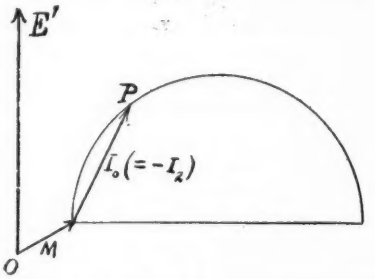


FIG. 5.—LOCUS OF TOTAL PRIMARY CURRENT.

The wattless component of the primary magnetizing current represents a flow of energy from the source of supply to the magnetic field of the motor and back again, while the wattless component of I_1 represents a flow of energy from the kinetic store of the rotor to the magnetic field of the motor and back again. When a two-phase induction motor has one of its stator windings detached from the source of supply, thus becoming a single-phase motor, the wattless component of the magnetizing current in the remaining stator winding is unchanged in value, the power component of this magnetizing current is doubled, and the rotor before rotating at constant speed, now rotates at a speed which rises and falls slightly at a frequency $2f$. This rise and fall of speed at zero load is due chiefly to the above-mentioned exchange of energy between rotor and cross-flux through the mediation of the wattless component of I_1, while under load the pulsations of speed are due not only to this cause, but also to the fact that the load torque is steady while the driving torque, equation (13), pulsates between zero and 2T.

The applicability of the Heyland diagram depends, as stated above, upon the fact that the flow of energy between the primary winding and the B winding of the rotor is identical to the flow of energy by ordinary transformer action from the primary winding to the B winding, on the assumption that the B winding has its resistance increased to the fictitious value $\left(\frac{f^2}{f^2-n^2}\right)R$. The ratio of transformation being 1 : 1 the equivalent resistance of the primary circuit is $R' + \left(\frac{f^2}{f^2-n^2}\right)R$. This resistance varies with speed. The reactance x of the primary is equal to $2\pi f$ times the inductance value of magnetic leakage which may be easily calculated from the dimensions of the motor. This reactance is constant. Therefore the locus of I_0 is a circle of which the diameter is equal to E'/x and at right angles to E′, and the locus of total primary current $M + I_0$ is the same circle with the origin displaced as shown in Fig. 5.

Having calculated M and x the diagram, Fig. 5, is completely determined. To calculate a set of corresponding values of speed torque, etc., proceed as follows: choose any point P, Fig. 5. This determines at once I_2, total primary current $M + I_0$, power-factor, and total power intake. Subtract from the power represented by the load current I_0 the resistance loss in the primary; namely, $(M + I_0)^2 R'$, and we have the total power delivered to the B circuit of the rotor. Thus from equation (11) the speed n may be calculated, I_2, R and f being known. Knowing n, the total torque exerted on the B circuit may be calculated from equation (13) from which total torque the amount $I_1^2 R/2\pi n$ is to be subtracted, this being the back torque due to rotor circuit A. To calculate this back torque consider that I_1 is sensibly equal to the wattless component of the primary magnetizing current M. The total power output of the motor, ignoring friction, may now be calculated from speed and net torque. Then the efficiency may be calculated. Proceeding in this way for a series of points P, Fig. 5, the data for plotting the complete performance curves of the motor may be obtained. The author's thanks are due to Mr. S. S. Seyfert for a careful verification of the equations given in this paper.

The Eleventh Annual Meeting of the German Society of Electrochemists.

Special Report by John B. C. Kershaw.

THE eleventh annual meeting of the German Society of Electrochemists, now known as the *"Deutsche Bunsen Gesellschaft fur physikalische Chemie,"* was held at Bonn—on the Rhine, on May 12, 13 and 14, and was eminently successful in every respect.

The society, which now numbers between 600 and 700 members, was represented by over 140 of these at the Bonn gathering, and the town and university authorities did all in their power to make the sojourn of the visitors pleasant and interesting.

The German professional world was represented by Professors Ostwald, Nernst, Van't Hoff, Anschutz and others, too numerous to mention; while Professors Roozeboom, of Amsterdam, and Arrhenius, of Stockholm, represented foreign universities. Switzerland, France, Austria, and England, also sent representative men to the gathering, which was thus fairly international in character.

The social features of the meeting were: a reception on Thursday evening; a Bier-abend (an eminently German institution), on Friday evening; a banquet on Saturday evening, and an excursion to the famous Drachenfels Castle on the Rhine, on Sunday. In addition to these festivities, the members had opportunities of social intercourse daily, at the public luncheon which was provided for them at the Hotel Kley, so that none could complain that provision for the physical or social animal had been neglected. In spite of these distractions, however, nineteen papers were read and discussed (in some cases at great length) and practically the whole of Friday and Saturday was devoted to the scientific work of the society. The papers and discussions on new applications of the "Phasen-lehre," and upon the "Chemical Mass-action of Toxines and Anti-toxines" excited most interest, and in each case notable differences of opinion were manifested. The papers upon technical or applied electrochemistry and electrometallurgy were few in number, and did not excite much interest. That by Dr. Rathenau upon a new method of preparing metallic calcium, was the most noteworthy and important. Dr. Goldschmidt's paper on the Ruthenberg iron process, contained nothing that has not already been published concerning it in England and America; but as members of the Bunsen Society are disposed to neglect this practical side of their science, it is perhaps necessary that old methods and processes should be brought to their notice in this way. It may be remarked however, that neither of these papers led to any discussion; while those upon the "Phasen-lehre" and the "Mass-action of Toxines," were keenly debated by the society as represented at Bonn. The tendency of the German electrochemist is toward the study of laws and principles, while that of the English and American electrochemist is to study only their practical applications in the arts and industries. All the scientific gatherings were held in the large lecture theatre of the Chemical Institute of the University, in Popplesdorf, a suburb of Bonn.

FRIDAY MORNING SESSION, MAY 13.

The proceedings opened at 9 A. M., with addresses of welcome from Dr. Böttinger, president of the society, from Professor Anschutz, director of the chemical institute of the university, from the burgermeister of Bonn, and from other representatives, including one from the Faraday Society of England. The first paper was read by Professor Roozeboom of Amsterdam, and dealt with "New Application of the Phasen-lehre to Mixtures of Carbon and Iron." The phase-rule which has been worked out by Van't Hoff and others for aqueous salt solutions, has been extended by Professor Roozeboom to cover solutions of carbon and iron, which he has found to obey precisely similar laws, and yield similar diagrams on cooling. When iron containing carbon is cooled, a part of the latter separates as graphite, and a part remains in solution in various modifications. By application of the phase-rule to such mixtures, the proportions of these various forms of carbon can be predetermined, for certain temperatures of cooling and original percentages of carbon; and the results obtained are believed by the author to be of considerable value to practical metallurgists.

The second paper by Professor Heyn of Charlottenburg, dealt with a similar subject, and was entitled, "The Hardening of Steel in its Physico-Chemical Aspects." Professor Heyn showed a large number of micro-photographs of steel of various compositions to illustrate his contention that valuable information can be obtained upon the hardening of steel from the preparation and study under the microscope of such polished and etched surfaces. These show crystal grains of pure iron, or ferrite, embedded in cementite, a combination of iron and carbon, in perlite, an eutectic mixture of ferrite and cementite; and these three constituents alter in amount and arrangement during the various hardening processes. Professor Heyn illustrated his paper with a diagram showing the separation of these constituents in samples of iron containing from 0.2 up to 1.40 per cent carbon.

The discussion on both these papers was postponed for want of time.

FRIDAY AFTERNOON SESSION, MAY 13.

The afternoon session was opened by a paper from Dr. W. Lob, of Bonn, upon "Pyrogenic Reactions and Dissociation Phenomena." The author has worked out an electrical method for studying these phenomena, which consists in the use of a small platinum coil heated by an electric current. This is fixed in the upper half of the flask apparatus, filled with the vapor of the liquid under observation; and by alternating the intensity of the current of electricity, the temperature of the small coil can be varied at will within wide limits, the temperature being calculated from the resistance and cross section of the wire. The dissociation of the various chlorine substitution products of benzol, has been studied in this way by the author, and valuable light has been thrown upon the constitution formula of many organic bodies. Unsaturated compounds, according to Dr. Lob, are dissociation products, in all cases.

The next paper was by Dr. Rathenau, and dealt with "A New Method of Preparing Metallic Calcium," by electrolyisis of its fused chloride. After giving the history of previous attempts to produce this metal in quantity, the author gave a few details of the method which has been worked out by the chemists of the Bitterfeld Elektrochemische Werke, of which he himself is managing director. The chief novelty in this method, is the use of what the author termed an interminable cathode; this cathode being arranged so that one end just touched the surface of the molten electrolyte, and being subject to an ascending vertical motion as the cathode deposit formed upon it. By using graphite rods as cathodes, and a suitable temperature and current density, it has been possible by this method to produces sticks of metallic calcium

of from one-half to one pound in weight, from a fused bath of its chloride. A large number of these sticks were exhibited by Dr. Rathenau, and each had the appearance of a collection of irregularly shaped buttons of the metals, stuck together by fusion. The color was dark gray, and the touch like that of graphite. No danger was incurred in handling them, if the fingers were dry. No use has yet been found for metallic calcium in quantity; but Dr. Rathenau is confident, that now the problem of its commercial production has been solved, its utilization in the arts and industries will follow.

This paper was followed by one by Dr. Jordis, of Erlangen, upon "New Theories Relating to Colloidal Substances."

In recent times it has been found possible to add largely to the number of substances which can be prepared in colloidal form, and gold, silver, platinum, copper and mercury can all now be obtained as colloids, and used in this form for medical and other purposes. The increase in the number of colloidal substances has necessitated a revision of some of the earlier views regarding them; and this was the point specially dealt with by Dr. Jordis in his paper. A lively discussion followed the reading of this paper.

The fourth paper read at the afternoon session was upon the "Passive State of the Metals" and was contributed by Dr. Müller, of Mülhausen.

The author attempted to prove that the generally accepted theory of the passive state of the metals, which attributes this to the action of the oxygen of the air, is incorrect; and that the presence or absence of positively charged electrons or ions was the factor determining the activity or passivity of metals, when used as anode in certain electrolytes. Professor Müthmann, of Munchen, acted as spokesman for the older theory, and stated that all metals which showed the passive state could be rendered active by polishing. In his opinion this conclusively proved that oxygen compounds forming on the surface of the metal were the cause of their passive state. Nine metals have now been found to show this phenomenon, manganese and niobium being the most interesting examples of passivity.

Dr. Sackur, of Berlin, contributed the fifth paper which dealt with the "Alloys of Lead and Tin."

The author considered the behavior of these alloys in the presence of weak acids worthy of study, since they are now largely used in the manufacture of cooking vessels, and of other articles of domestic use.

The method of investigation was based upon determinations of the condition of equilibrium, when first lead and then tin was displaced from its solution by the other metal, in various weak acids, and the results obtained were shown to be in harmony with Nernst's theory and laws. The corrosion and solution of these alloys proved to be due to oxidation of the metal, by the active oxygen of the solution used. In dilute acetic acid solutions lead was found to be more soluble than tin; whereas, with concentrated solutions, the solubilities were reversed. The author explains this phenomenon, by the theory that in each case lead is primarily dissolved; but that in strong solutions this lead displaces tin by secondary action.

The next paper by Dr. Goldschmidt, of Essen, was illustrated by lantern views, and was one of the few papers dealing with industrial electrometallurgy. Dr. Goldschmidt has recently visited America, and his paper was a description of the "Ruthenberg Electrical Process for Concentrating Iron Ores." This process has been several times described in the columns of the ELECTRICAL REVIEW by the present writer and others, and Dr. Goldschmidt's paper contained no new information relating to it. He thinks Ruthenberg's figures for the power required to concentrate one ton of ore (250 kilowatts) is somewhat low, and he considers that the second part of the process in which the "agglomerated ore" is to be reduced by gases in a "soaking pit," of doubtful practical value. The works at Lockport, where the Ruthenberg process is undergoing experimental trial, are also smaller than he expected.

The two final papers read at the afternoon session of Friday were by Dr. Tammann, of Göttingen, and by Professor Mathesuis, of Charlottenburg. The first was theoretical in character and dealt with the "Formation of Glass Crystals" in masses of amorphous glass; while the second was practical and dealt with the "Formation, Constitution and Utilization of Slags in Furnace Processes."

SATURDAY MORNING SESSION, MAY 14.

The session of Saturday morning, after the transaction of business matters, and a short address from Professor Ostwald upon a "Welt-Sprache" in which he is greatly interested, was devoted to a group of papers dealing with miscellaneous subjects, the most important being that by Professor Ostwald upon "New Applications of the Phasen-lehre."

It is impossible in a brief abstract to attempt to reproduce the main points of this lecture, and readers interested in the subject may be referred to the *Zeitschrift für Elektrochemie,* of June, which will contain a detailed report of Professor Ostwald's address on this subject. It was stated in the course of the lecture, that the laws governing the reactions and combinations of compounds are exactly similar to those governing the reactions and combinations of elements, and therefore, the atomic theory of Dalton is apparently not required to explain many of the phenomena of chemical action. Professors Van't Hoff, Nernst and Roozeboon, joined in the discussion upon Professor Ostwald's address; and this discussion was notable for the differences of opinion in relation to this subject and upon certain fundamental points, held by the leading electrochemists of the Continent.

The second paper of the morning session was by Dr. Eebs, of Giessen, and dealt with "Stereometric Difficulties in Certain Reduction Processes." This paper was entirely chemical in character, and an abstract of it would not interest readers of this journal.

The next paper by Dr. Bredig, of Heidelberg, upon the "Catalysis of Cyanogen Compounds," dealt with the chemical reactions which are brought about by the action of this chemical without any apparent change or loss of the cyanogen, and the author put forward the theory that in such cases, an intermediate stage occurs, in which the cyanogen ion enters into combination with the molecule of the reacting compound.

The two final papers of the morning session were by Dr. Bose, of Göttingen, and Dr. Trautz, of Freiburg. The first related to the "Chemical Action of Cathode Rays," and detailed the results obtained in experiments with a special form of apparatus, in which molten caustic potash was employed at the anode pole in an exhausted receiver, with a discharge potential of 3,200 volts. The volume of hydrogen liberated under these conditions was enormously in excess of that calculated by Faraday's law, and Dr. Bose considered that the great discrepancy was due to the kinetic and mechanical action of the rays.

According to Dr. Bose one ampere-second employed in producing cathode rays will liberate 1,800 cubic centimetres of hydrogen gas; while the electrochemical equivalent of this energy, is only 0.116 cubic centimetre of hydrogen.

The paper by Dr. Trautz dealt with "Light Phenomena in Chemical Reactions," and was illustrated by two striking experiments in the darkened room. According to Dr. Trautz, a very large number of chemical reactions exhibit lu-

minous phenomena when studied in the dark and in some cases this is of striking intensity.

SATURDAY AFTERNOON SESSION, MAY 14.

The afternoon session of Saturday was devoted to the reading and discussion of four papers of medical interest and was considered the most successful session of the meeting, since a large number of medical men were present and very animated discussions followed the reading of each paper.

Two papers by Dr. Schroeder, of Bonn, and Dr. Dreser, of Ebberfeld, dealing with physical observations upon the urine and the blood were first read; and then came what was the chief feature of the Bonn meeting—the lecture by Professor Arrhenius, of Stockholm, upon the "Chemical Mass-action of Toxines and Antitoxines." In opposition to the generally accepted views and theory, Arrhenius has come to the conclusion that toxines and anti-toxines follow the usual laws of chemical action when introduced into the animal organism; and he supported this view by giving details of his recent laboratory investigations upon this subject. Dr. Ehrlich, of Frankfort, led the opposition to Professor Arrhenius's view, and a very lively and somewhat violent debate ensued. The final paper by Professor Nernst, upon the "Action of High Potential Discharges of Electricity upon the Nervous System," was also of considerable interest and importance.

Electrical Men Enjoy Planked Shad.

Mr. Charles E. Trump, president of the Novelty Electric Works, gave his annual planked shad dinner to a number of friends at Washington Park near Philadelphia, on Wednesday of last week. This was the twelfth annual meeting, and was participated in by a party of eighteen. The shad were freshly caught in nets that morning and were served in the way peculiar to Washington Park, which has become famous for its planked shad dinners.

A number of gentlemen attended from New York, besides several Philadelphia friends of Mr. Trump, among these being M. T. Trump and George Steele, of Philadelphia; Captain W. L. Candee, George T. Manson, H. D. Cheever, W. H. Hodgins and Charles Cuttriss, of New York. Senator W. H. Thompson, the owner of Washington Park, extended a cordial welcome to his visitors. As the next planked shad dinner will be the thirteenth, it was proposed to hold it on Friday so as to bring good luck to all participants.

JOINT SESSION OF THE BRITISH AND AMERICAN MECHANICAL ENGINEERS.

CHICAGO, ILL., MAY 31 TO JUNE 3.

A joint meeting of the American Society of Mechanical Engineers and the Institution of Mechanical Engineers, of Great Britain, was held in Chicago, Ill., from May 31 to June 3, inclusive. The meeting was opened on Tuesday, May 31, with an address of welcome by Mayor Carter H. Harrison. This was responded to by Mr. Ambrose Swasey, president of the American Society of Mechanical Engineers, and Mr. J. Hartley Wicksteed, president of the Institution of Mechanical Engineers. A reception was held in the main parlor of the Auditorium Hotel in the evening.

On Wednesday morning the business sessions began. Papers were taken up as follows: "The Wage Problem," Harrington Emerson; "Some Recent Examples of Destructors for Town Refuse," George Watson; "Refuse Destruction by Burning, and the Utilization of Heat Generated," C. Newton Russell.

A tally-ho drive was given to the ladies on Wednesday morning, the party being taken through the boulevards and south parks. Luncheon was served at Jackson Park, and a visit made to the Field Columbian Museum in the afternoon. On Wednesday afternoon the members of both societies were the guests of the Illinois Steel Company, at South Chicago.

"Steam Turbines" was the topic for discussion on Wednesday evening. The meeting began about 8.30 P. M., and was held in the music hall of the Fine Arts Building. Several papers were presented on the subject of steam turbines. That on "Some Theoretical and Practical Considerations in Steam Turbine Work," was by Mr. Francis Hodgkinson. A paper entitled "The De Laval Steam Turbine" was presented by Mr. E. S. Lea and Mr. E. Meden. "The Curtis Steam Turbine" was presented by Mr. W. L. R. Emmet. "Different Applications of Steam Turbines" was presented by Mr. A. Rateau. Mr. C. A. Kerr presented a paper entitled "The Potential Efficiency of Prime Movers."

On Thursday morning, during the session at the Auditorium, the ladies accompanying the members assembled at headquarters, and the party made a tour of the downtown department stores. Luncheon was served at one of the stores at noon. In the afternoon Mrs. Robert W. Hunt entertained the ladies at her Chicago home.

The papers taken up Thursday morning were "Power Plant of the Tall Office Building," J. H. Wells; "Power Plants of Tall Office Buildings," R. P. Bolton; "Middlesbrough Docks Electric and Hydraulic Power Equipment," Mr. Vincent L. Raven; "Use of Superheated Steam and Reheaters in Compound Engines of Large Size," Mr. Lionel S. Marks, "Commercial Gas Engine Testing and Proposed Standard of Comparison," Mr. William P. Flint.

In the afternoon excursions were made to the Fisk street station of the Commonwealth Electric Company, the members of both societies being guests of the Chicago Edison Company. In addition to this, visits were also made to the stockyards and packing-houses as guests of Swift & Company.

On Thursday evening the local members of the American Society of Mechanical Engineers tendered a reception to the officers and members of the two societies and the ladies accompanying at the Art Institute.

On Friday morning the ladies were conducted in carriages through Lincoln, Humboldt and Garfield parks, to the Lewis Institute. During the morning the members of both societies met at Lewis Institute, where reading and discussion of the following papers were taken up: "Cast-Iron Composition, Strength and Specifications," Mr. William J. Keep; "The Effects of Strain and Annealing," by Mr. William Campbell; "Experiments with a Lathe-Tool Dynamometer," Mr. J. T. Nicolson; "Road Tests of Consolidation Freight Locomotives," Mr. E. A. Hitchcock.

The engineers and ladies were the guests of the Lewis Institute at luncheon, and at two o'clock a special train on the Atchison, Topeka & Santa Fe Road was boarded, and the party inspected the yards of the Chicago Terminal Transfer Company. Later in the afternoon the party made a trip to Lockport, to view the drainage canal and the large controlling works.

On Friday evening the visiting members were given a concert by the Thomas orchestra in the Auditorium by the local members.

The next joint meeting will be held in New York city.

Machinery Hall, unlike the other buildings at the St. Louis World's Fair, is not closed in the evening. It is open until 11 P. M., and visitors in the evening will find at work there, among other objects of interest, the 5,000-horse-power Allis-Chalmers-Bullock engine and generator, producing current for decorative lighting for the buildings and grounds.

Reviews of Current Engineering and Scientific Literature.

Compounding Three-Brush Dynamos.

When the voltage of a dynamo is divided by means of a third brush, it is usual to divide the compounding so as to have half in each of the outer wires. In this way the compounding of the machine is controlled by the currents flowing in the outers, and there is no unbalancing. Sometimes this arrangement can not be made, as it is impossible to divide the compound winding. To provide for this condition, the arrangement here described by Herr E. Rosenberg has been devised. This consists merely in placing on the machine a compound winding, which is connected in the neutral circuit, and which then carries the difference between the currents flowing in the outers. The system is applicable both to machines having three brushes and to those where the potential is divided by the Dobrowolsky system, by means of an induction coil. This winding acts with or against the main compound winding, and since it carries only the differential current, it need be proportioned only for this. It is therefore smaller than a second winding placed in the outside wire.—*Translated and abstracted from Zeitschrift für Elektrotechnik (Wien), May* 1.

Experience of a Cable Ship on the Amazon.

The telegraph steamer *Viking,* detailed to repair one of the cables in the river Amazon, recently had a strange experience. The fault had been localized at a spot where the cable was laid in one of the numerous streams out of the strong current of the main river. After grappling for some time without success, the vessel moved a mile down stream, where the channel passed close under a fringe of high trees. At the first attempt the cable was hooked, and, after being cut, work upon drawing in the damaged portion commenced. After taking up half a mile of the cable, it left the open water and led into the coarse grass which fringes the low banks of the river, and which consequently floats in immense quantities on the surface of the deep water. Picking up was continued, in the hope of being able to pull the vessel through the grass to the other side, as the water was twelve feet deep. The grass, however, choked the circulating pumps, cutting off the supply of water to the boilers. As the vessel proceeded, the grass formed a compact mass ahead, which could not be cleared away, until finally conditions became such that it was impossible to draw in any more of the cable. It was cut off, and only after considerable difficulty did the *Viking* succeed in pulling herself out from the mass of grass. It was found that a considerable part of the cable would have to be abandoned, as the channel of the river has changed completely. Where there was water fourteen feet deep four or five years ago, there is now an island with fair-sized trees under which the cable passes.—*Abstracted from the Electrical Review (London), May* 20.

Apparatus for Transmitting Writing and Drawings Telegraphically.

Professor Cerebotani, of Munich, described recently at a meeting in Berlin an interesting telegraphic device of his invention. The principles of this instrument are here outlined by Dr. A. Gradenwitz. It is said that the system was tested successfully on telegraph lines between Munich, Augsberg, Milan and Rome, Milan and Turin, and finally Munich and Berlin. The inventor contemplates applying his system to wireless transmission of writing and drawings, this being possible on account of the very small currents required to operate the apparatus. The sending device is formed of four coils, each having two windings, the coils being placed on a small table so as to cross each other. According as the currents passing through these bobbins are more or less intense or have the same or opposite sense, currents varying in two senses are obtained, which produce corresponding magnetic effects. The variety and number of these current impulses are practically unlimited. The receiving apparatus is similar to the sender. The system can be used as a printing telegraph, but this application is not important, as it has little or no advantage over other printing systems, except perhaps as applied to wireless transmission. The most important use will be for transmitting writing. For this purpose the transmitter is fitted with a pen, the motion of which controls the currents passing through the transmitting coil. A similar arrangement of the receiver causes the pen at that point to follow all the motions of the sender. A speed of 100 letters per minute is easily attainable, and the apparatus can be applied simultaneously on lines operating with the ordinary Morse system. Distances of transmission are unlimited, since it is possible to make use of relays.—*Translated and abstracted from L'Électricien (Paris), May* 14.

The Cable Steamer Pacific.

The cable steamer Pacific, built for the Great Northern Telegraph Company, London, left England recently for Shanghai. This is the latest ship of its class, and probably has a more complete cable-repairing equipment than any other. The vessel has a gross tonnage of 1,570, and engines rated at 1,700 horse-power. She has twin screws, is 260 feet long and thirty-five feet six inches broad, and has a maximum speed of twelve knots. She has three cable tanks, which will hold about 450 miles of deep-sea cable. When the vessel left the docks, the tanks were nearly full, containing cables of various classes, supplied by the Telegraph Construction and Maintenance Company, Henley's Telegraph Works and Hooper's Telegraph and India Rubber Works. That from the latter was recovered rubber core. This core had been laid thirty years ago in some of the oldest cables of the Great Northern company, and when picked up, it was found that, although the armoring needed renewing, the rubber core itself was in excellent condition in most cases. The double combined picking-up and paying-out machine comprises practically two separate machines, both of them used either for picking up or paying out, each machine having a separate engine. These machines are controlled by brakes, which, when tried, held a maximum load of twenty-five tons, and enabled this load to be lowered easily and under perfect control. For hauling the cable from the picking-up machine to the cable tanks, and for turning over the cable from one tank to another, the vessel is supplied with portable steam and electric hauling gears. The electric hauling gear consists of a V-hauling sheath in cast-iron frames, and driven through the medium of bevel and worm gears by a six-horse-power motor. This is entirely enclosed and watertight. Current is supplied from the power plant in the engine room. The ship is liberally supplied with electric lights, fans, a searchlight, etc. The engine room has, in addition to the usual ship telegraph, a loud-speaking telephone installation. The testing room is fully equipped with all necessary instruments. These

have been mounted with a view to avoiding vibration. Each galvanometer is placed on a thick felt mat, laid in a shallow box. An engineers' workshop contains the necessary machine tools, all driven by an electric motor.—*Abstracted from the Electrician (London), May 20.*

Action of Hertz Waves on Sources of Light Having Small Intensity.

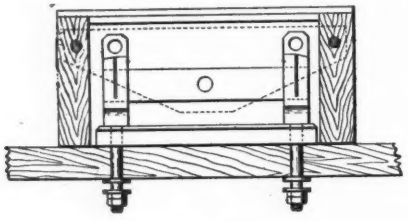
The effect of a varying magnetic field upon faintly luminous sources of light has already been investigated. In this note, communicated recently to the French Academy of Sciences, by Mr. C. Gutton, the similar effect of electric waves is described. Believing that the electromagnetic waves emitted by a Hertz oscillator would affect a phosphorescent screen, the author repeated Hertz's experiments on rays of electric force, using, in place of a resonator, a phosphorescent screen. The oscillations were produced by a small Blondlot oscillator two centimetres in diameter, immersed in oil. They were conducted by two wires nine metres long to two antennæ four centimetres in length, placed along the focal line of a cylindrical parabolic zinc mirror. The bundle of electric rays reflected from this was received by a second similar mirror and concentrated upon a phosphorescent screen, also placed along the focal line. The distance between the foci of the two mirrors was one metre, and the oscillator and the mirrors were placed in separate rooms. All precautions were taken to avoid any disturbing action due to the oscillating sparks upon the phosphorescent screen, and the wires conducting the waves from the oscillator to the mirror were covered with gutta-percha and placed quite close together. Oscillations were set up by means of a Holtz machine, attached to the inner coatings of two Leyden jars. The outer coatings of the latter were connected to the oscillator. This arrangement was adopted, since the use of an induction coil was not allowable, there being no way to prevent the disturbing effect of the magnetic field of the latter. Upon setting up Hertz waves by means of the oscillator, the calcium sulphide screen became more luminous. This increase was even greater than that due to the action of the magnetic field. To prove that the effect was due to the Hertz waves, and not to other disturbances, various screens were introduced. A conducting screen stopped all action, while other screens had no such effect. Polarization of the waves was shown by placing a system of copper wires—arranged parallel to one another and one centimetre apart—between the mirrors. Turning this system about in the plane, normal to the path of the waves, the phosphorescence of the sulphide screen increased and decreased, becoming a minimum when the wires were parallel to the direction of the electric force, and a maximum when they were perpendicular. It was possible in this way to determine the plane of polarization within a few degrees. Reflection of the electric waves was also shown easily. It was found that the effect of the Hertz waves was similar to that of the N-rays, the illumination being increased when the screen is observed normally, and decreased when observed tangentially. It was suggested that the Hertz wave resonator be modified so as to make use of a phosphorescent screen in place of the small spark in air. To accomplish this, to the extremities of the resonator two small metallic plates are soldered parallel to each other. The electromagnetic field between these is intense, and between them a small phosphorescent screen may be placed, and observed from one side.—*Translated and abstracted from L'Industrie Electrique (Paris), May 10.*

The Life History of Radium.

It was suggested recently by Mr. W. C. D. Whetham, that radium is being produced from uranium. This matter has been under investigation by Mr. Frederick Soddy for a year, and although the investigation has not been completed, he thinks it well to describe his first results. Twelve months ago Mr. Soddy purified a kilogramme of uranium nitrate until the quantity of radium present was less than 10^{-13} gramme. This was the limit in detection by means of the electroscope then available. Unfortunately, owing to the large amount of radium in the laboratory, the electroscope there had been affected, and it is not possible at the present time to be sure of such minute effects as originally. But it may be stated that less than 10^{-11} gramme of radium has accumulated in the kilogramme of uranium during the past twelve months. This, Mr. Soddy believes, practically settles the question, so far as the production of radium from uranium is concerned. In a paper read recently before the Royal Society by Sir William Ramsay and Mr. Soddy, it was shown that rather less than one-thousandth part of radium changes per year. The rate of change of uranium may be taken as a million times slower, so that, in one kilogramme of uranium nitrate, about 5×10^{-7} gramme would change per year. From the results given above, the conclusions arrived at are, that if uranium changes into radium, less than one-ten-thousandth part of the theoretical quantity is produced during the first year's accumulation. This result may be explained by assuming the existence of intermediate forms between uranium and radium; but, from a general consideration of the whole question from the point of view of the disintegration theory, several such hypothetical forms, each with an extended life, must be assumed. This is not justifiable at present, and the evidence may be taken as indicating that uranium is not the parent element of radium. The question of the life of radium is discussed also by Mr. J. Joly. The decay of radium, as shown by Ramsay and Soddy, renders it out of the question to assume that the radium now existing on the earth is the residue of a larger quantity, reduced by decay to its present amount. If we carry backward so great a rate of change, we arrive at the existence of such large amounts, quite a few thousand years ago, as to postulate a red-hot earth almost within historical times. We are thus either compelled to assume that the rate of transformation observed does not apply generally to terrestrial radium, but only to radium separated by chemical treatment from pitchblende; or that the existing store of radium is derived by a steady supply from some substance of greater atomic weight. Assuming that uranium breaks down to form radium, and assuming as an approximation that from one-thousand kilogrammes of uranium the yield of radium, under most favorable conditions, would be one decigramme, this, at the rate of decay of radium, would produce one-tenth milligramme of substances of less atomic weight per year. In other words, the uranium breaks down at the rate of $\frac{1}{10^{10}}$ part of its mass per year, and its average life is, according to this, ten thousand million years. On these assumptions, an interval of time is indicated, which may be considered as a minor limit to the antiquity of matter in our part of the universe. As compared with this, geological time—as we guess it—is but little more than a moment in the being of so great an era, as thirty-six seconds is to an hour. It is interesting to note that the rate of change of thorium to thorium X affords the same average longevity for the atom of thorium.—*Abstracted from Nature (London), May 12.*

Electrical Patents.

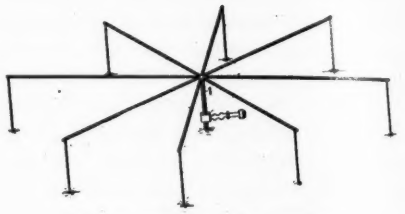
Mr. Fred C. Corey, of Schenectady, N. Y., has assigned to the General Electric Company, New York, a patent recently obtained by him on blowout chutes. Magnetic blowout chutes as heretofore constructed are provided with a blowout coil to develop the field which extinguishes the arc, and as the coils are connected in series with the terminals they must be of sufficient cross-section to carry the entire current. In the present device, the auxiliary coils are dispensed with and the magnetic field is developed solely by the passage of the current through the fuse or between the terminals. To accomplish this, iron plates are mounted on or within the sides of the enclosure and the current passing between these plates magnetizes them. This greatly reduces the cost of the device and conduces toward simplicity and compactness. The general features of the present invention are the same as those set forth in a previous application made by Mr. Corey, serial No. 121,714, filed September 2, 1902, but in this case



Blowout Chute.

is included only an enclosure adapted to be applied to and withdrawn from a fuse or terminals of any kind between which an arc is liable to form, no terminals whatever being connected with the enclosure. In order to ensure a complete extinction of the arc, the magnetic field is so arranged that the path of least reluctance is always immediately behind the arc, causing a maximum concentration of the field at that point. This is done by placing the magnetic pole-pieces so that they extend on either side of the path of the arc, and short-circuiting the lines of force on one side so that a magnetic field is established only on the other side. Thus when an arc is formed the field of force lies directly below the arc and repels the arc stream, and as the arc is stretched, due to the explosive force of the magnetic field, this field follows it up until it is extinguished. In carrying out the invention Mr. Corey makes an enclosing chamber or chute of any non-combustible material and mounts within or on the outer side of the sides of the enclosure metallic plates, such as iron, of high permeability. These plates are so placed that they extend both above and below the line along which the current passes; but above that line and outside of the inner walls of the chute they are connected with iron yokes or rivets which divert the lines of force from above the path of the current, thus concentrating the magnetic field below the path only. The current passing between the plates magnetizes them, and a magnetic field is established across the air-gap below the fuse or terminals. Should the fuse blow or an arc strike across the terminals, the magnetic field acting directly behind the arc blows it outward, but as the arc blows the field of force follows it up and blows it more and more until it is extinguished. The invention, therefore, comprises a blowout chute to be applied to or withdrawn from arcing points in an electric circuit having iron plates mounted and overlapping on either side the line of passage of the current and adapted to be magnetized by the current passing within the chute; and further, it comprises means on one side for diverting or short-circuiting the lines of force or reducing their density, thus establishing a strong field at only one side of the line along which the current passes.

Mr. Guglielmo Marconi, a subject of the King of Italy, residing at London, England, has invented certain improvements in wireless signaling systems, the patent obtained on which he has assigned to Marconi's Wireless Telegraph Company, Limited, a corporation of Great Britain. The invention has for its object the provision of means whereby etheric vibrations or Hertzian waves or electrical oscillations of high frequency, such as are used in the systems of wireless telegraphy, may be transmitted to greater distances at smaller cost and by means of less expenditure of electrical energy than has been required in systems previously used. The invention relates particularly to the aerial or elevated conductor used in connection with such systems for radiating or receiving the etheric vibrations or Hertzian waves or electrical oscillations of high frequency. Heretofore it has been the practice to use for this purpose an upright mast or other support for the aerial conductor, with or without a capacity area at the top, from which waves or vibrations are to be radiated or upon which they are to be received. The distances to which the messages can be sent and detected, it has been found, depend upon the height to which the conductor is carried. It is not practicable, however, to carry such conductor to a height greater than two hundred feet, and it has been found that with an elevated conductor of a given height the distance to which messages can be sent can be increased by increasing the electrical energy by means of which the etheric waves are produced. According to the present invention, one or more members, consisting of wires or rods, are connected to the vertical elevated conductor, also in the form of a wire or rod. The members extend from this elevated conductor in a lateral or outward direction. The vertical portion of the aerial



Wireless Signaling System.

may then be made comparatively short and the necessary length and capacity secured by lateral extension. The lateral aerials may extend either in a horizontal plane or may be inclined either above or below such a plane. These outwardly extending members may be carried for a considerable distance from the upright aerial conductor and thereby greatly extend the distance across which signals may be sent or received without involving serious difficulty in supporting and maintaining them, and in such case their free ends are preferably supported directly from the ground, but insulated from the support and from the ground.

Mr. Claude J. Keplinger, of Canton, Ohio, is the inventor of an improved brake handle, the object of which is to provide a handle which will not become charged with electricity from any cause, and will

Brake Handle.

be free from contamination and can be operated without danger of shock or injury in any way. The patent obtained on the invention has been assigned to the Canton Hard Rubber Company, Canton, Ohio. The invention consists of a handle adapted to be attached to the brake or controlling mechanism of a car, consisting of a metal centre or base, the personal contact surface of the metal centre or base being provided with a permanent and integral outer insulating shell.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Some New Westinghouse Apparatus.

The Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., has placed on the market a new type of lightning arrester for which it claims several points of more than ordinary merit. The application of lightning arresters is well known, and some of the difficulties under which this apparatus works are also widely known. By reason of the nature of the service which a lightning arrester is designed for, it is necessary that the arrester offers an easy path to the earth for a static charge, which may be impressed on the line. While the arrester must afford an easy path of discharge,

FIG. 1.—"M. P." LIGHTNING ARRESTER.

it must also be so constructed that the line current will not be permitted to follow the static discharge.

To meet either of these requirements alone is a simple problem. These essential requirements are, in a sense, antagonistic, and compromises have often had to be made between the two.

During extended investigations of static phenomena and protection of apparatus from lightning discharges, Mr. Percy H. Thomas has discovered that to successfully protect apparatus operated on low-voltage circuits, such, for example, as railway motors and generators, it would be necessary to produce an arrester which would offer a very easy and open discharge path to earth. To protect an arrester from damage due to the line voltage holding over was also an essential requirement. Experiments have been carried on both in the laboratory and under active service conditions for several years with the result that the Westinghouse company has produced an arrester which has, it claims, a superior protective power, and promises to have an almost indefinite length of life.

Two general principles underlie the successful operation of the new arrester: (1) There is a minimum voltage, below which an arc can not be maintained across an air-gap, no matter how small that gap may be. (2) Under proper conditions a static discharge will distribute itself over a great number of parallel paths, so that the amount passing over any one path will be very small, producing practically no heating or disintegrating effect.

From this second principle the arrester (Fig. 1) takes its name, "Multi-Path" (M. P.).

The arrester consists essentially of a specially prepared block of carbon, in which the area offered for discharges is very great as compared to the length of path through which the discharges pass. In this block there are a great number of separate conducting paths, and the discharge passing through the block divides and takes simultaneously many different ones. Each of these paths is broken up by a large number of minute air-gaps, so that the voltage across each gap is very small and the line voltage can not maintain an arc across them. Thus the arrester is non-arcing, since the line current does not follow the static discharge.

In series with the carbon is a small air-gap rigidly maintained between two metal surfaces. This air-gap keeps the arrester insulated from the line, except at the instant of a discharge. The active parts of the arrester are enclosed in a cast-iron box which is filled with a waterproof compound.

The arrester is weatherproof and fireproof. It may be used indoors or outdoors, may be located in practically any position desired and used on circuits for 250 to 850 volts, either direct or alternating current. Its weight is very small for an arrester of its capacity. It is small and compact and has no moving parts to stick and get out of order.

Fig. 2 and Fig. 3 show the Westinghouse oil-immersed three-point autostarter designed for use with Westinghouse type C induction motors as shown in the accompanying illustration. It is used for motors of five to fifty horsepower; smaller motors of this type being

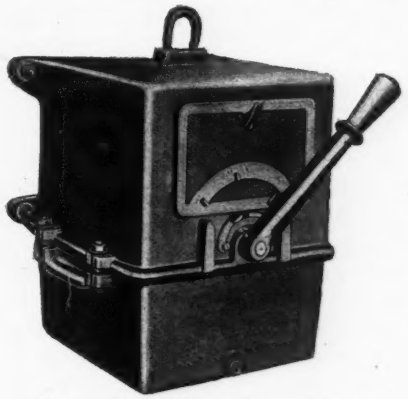


FIG. 2.—THREE-POINT AUTOSTARTER.

started by closing the circuit with an ordinary switch, and starting controllers of another type being used for motors larger than fifty horse-power.

In effect, the autostarter consists of an oil-submerged drum switch used in con-

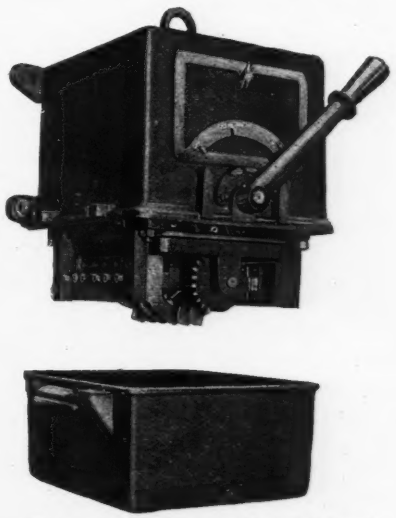


FIG. 3.—MECHANISM OF THREE-POINT AUTOSTARTER.

nection with a pair of autotransformers which have loops so arranged that a choice of two of several starting voltages is given. It thus combines the functions of a line switch in opening and closing the circuit with those of a controller or starting rheostat with two reduced starting voltages.

The switch, which is of the horizontal

drum type, is placed in the oil tank with all live parts submerged, the handle and drum being so connected by gearing that the handle shaft is brought out above the level of the oil. In the style used with five to fifteen-horse-power motors, the switch is a simple drum on which the fingers bear directly, but in the twenty to fifty-horse-power sizes, which carry larger currents, blades on the drums slide through jaws, giving large area of contact. The drum contacts and contact fingers can be easily renewed, and if desired the entire drum can be detached. The absence of flexible leads is of advantage here, as it facilitates the removal of the drum and ensures durability.

The drum is so arranged that the movement of the handle is progressive, passing in succession from the off position through the two starting notches to the running position. There is no possibility of moving the handle directly to the running position without first applying the starting voltages as is frequently done by mistake when the off position is placed between the starting and running positions and the handle is thrown first in one direction and then in the other. Nor is the operator so liable to leave the handle in a starting position and ruin the autostarter by overheating the transformer. The handle is usually placed as shown, but if desired it can be reversed, so that the hand moves below the shaft.

The connections between the drum switch and the autotransformers are arranged to give the best starting voltages and are adjustable, to suit the conditions of service. Each of the transformers has five taps, giving, respectively, thirty, forty, fifty, sixty and eighty-five per cent of the full line voltage, and by changing the connections between the transformers the starting voltage can be changed to give the torque desired. When the handle is in running position connection is made directly between the motor and the line, the transformer being cut out. When the handle is in the off position, both the transformer and motor leads are disconnected, the only live parts being the leads from the generator.

Changing the connections is also facilitated by bringing the transformer taps to the front of the case where they can be readily reached by removing the handhole cover shown in the illustrations.

In addition to the features mentioned, there are a number of others in which the convenience to the user has been consulted. Access to the drum is facilitated by slotting the lugs through which the bolts pass, so that when the nuts are loosened the bolts can be withdrawn sidewise and the tank lowered. The proper oil level is distinctly marked and drainage and filling tubes are conveniently located. The tank is tightly fitted to the upper portion of the case, and by providing the main hole cover with an airtight gasket the interior can be protected against acid fumes or dangerous gases. This feature together with the submersion of all live parts in oil makes it possible to use the autostarter where there are inflammable gases or combustible floating particles in the air. As a precautionary measure, the handle is locked in each of the four positions, being released by a pressure upon a button on the end of the handle, this preventing a too-sudden starting of the motor. The fact that the autostarter may be placed at any distance from the motor is also an advantage, when motors are suspended from ceilings or placed in other convenient locations.

Some P. & S. Specialties.

The accompanying illustrations show two specialties from Pass & Seymour,

FIG. 1.—SIGN RECEPTACLE.

Inc., Solvay, N. Y. Fig. 1 represents a sign receptacle, adapted to be inserted from the back of the supporting board,

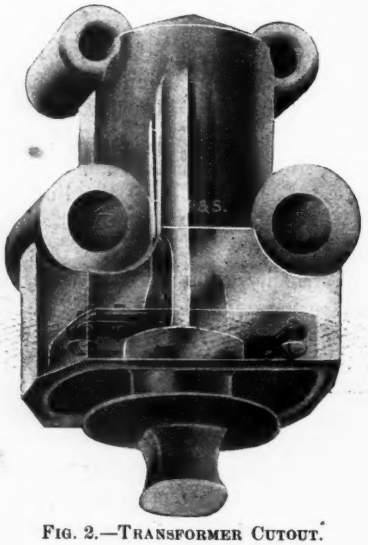


FIG. 2.—TRANSFORMER CUTOUT.

in a compact series, so that they may be wired from the back. The lamps are inserted from the front. These receptacles are strong and durable and their constructions make installation easy and economical.

Fig. 2 shows a transformer cutout which has been in extensive use for a number of years. These cutouts have been improved recently, and are made of the highest grade of vitrified porcelain, and equipped with brass screws and copper terminals throughout. They will take a five-inch fuse and carry a load of thirty amperes at 2,500 volts. Large chamber and holes in the side of the box facilitate the insertion of leading-in wires. The plug can not drop out of the box as it is secured in place by a knife contact requiring a half turn, and it can be removed while the current is on the line without danger to the operator.

Tests of Steam Locomotives on the Marienfelde-Zossen Line.

The military railroad from Marienfelde to Zossen has been reenforced since the tests of high-speed electric traction, and has been employed for testing high-speed steam locomotives. Four types of express locomotives have been tried. Two of these locomotives are of the ordinary four-cylinder type, having three axles, two of them driven. The third locomotive has four axles, two being driven. This is fitted with a Schmidt superheater. The fourth locomotive was especially built for exhibition at the World's Fair, St. Louis. It has four axles, two being driven. Tests were made with six-car and three-car trains. The first two locomotives developed, the one sixty-nine and the other seventy-three miles per hour. With three-car trains, the speeds were seventy-six and one-half and seventy-eight miles per hour, respectively. The last two locomotives, with six-car trains, developed seventy-nine and one-half miles per hour, and with three-car trains, eighty-four and one-half miles per hour. Tests have also been made on a section of the state railway, near Marienfelde, but on account of the lightness of the construction, speeds of over fifty-six miles an hour were not safe.

Letters of Alessandro Volta.

Professor Caloria has exhibited at l'Instituto Lombardo delle Scienze, of Milan, letters written by Volta and the Dutch scientist, von Marum. There are sixteen letters from Volta to von Marum, and nine letters from the latter to Volta. They are dated from 1782 to 1802. Two of these letters, dated August and October, 1792, show that, at that time, Volta had already invented his pile; but, due possibly to his controversy with the partisans of Galvani's theory, or possibly on account of the conditions at the time, his discovery was not published until March, 1800.

Dynamotors and Motor-Generators.

The Holtzer-Cabot Electric Company, of Boston, Mass., has for many years given special attention to the construction of dynamotors and motor-generators. Fig. 1 shows a dynamotor or double-wound machine, in which one armature core holds both motor and generator windings, which rotate in a common field. The bearings are all of hard phosphor-bronze, self-aligning and self-oiling, while the shafts are of crucible steel, ground to gauge and polished at the bearings. The armatures, with the exception of those made especially for telephone work, are of iron-clad construction, being carefully built up of laminations of soft steel. The commutators are of hard-drawn copper in the smallest sizes, and drop-forged in the larger, and the segments are insulated from each other by soft amber mica. Adjustable rocker arms or rings are used on all sizes.

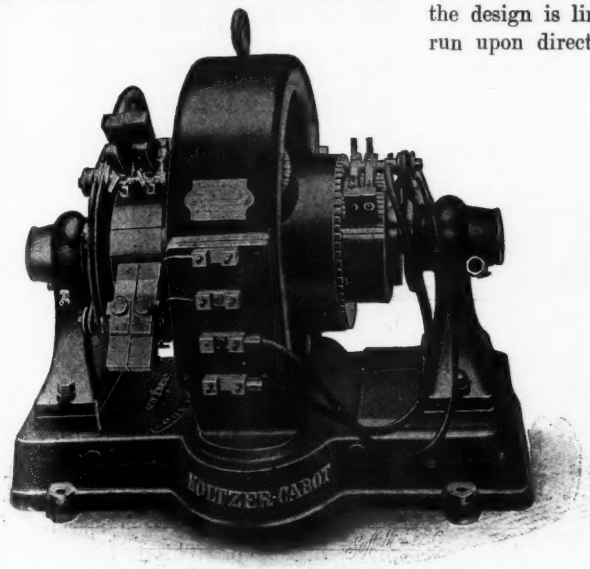


Fig. 1.—Open Type Dynamotor.

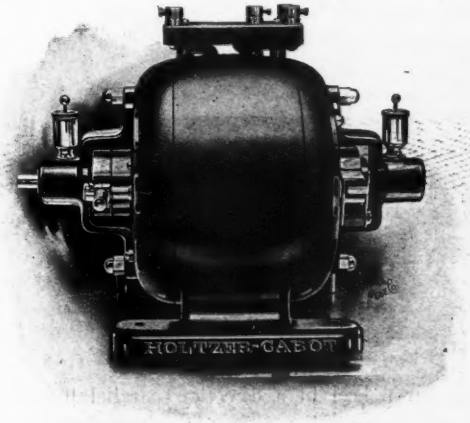


Fig. 2.—Enclosed Type Dynamotor.

While Fig. 1 shows a dynamotor of the open type, Fig. 2 shows a dynamotor of a smaller size, which is an enclosed type machine. With this class of machinery, the design is limited to machines which run upon direct current and deliver alternating or pulsating current for ringing purposes, or direct current of a higher or lower voltage for charging batteries, plating, testing, etc.

Because of their compactness, these machines will be found valuable in many fields of work where the primary voltage is not too high.

Fig. 3 shows a motor-generator of a type which has been adopted by several large users of this class of apparatus. The two intermediate bearings are dispensed with, and the two armature cores are carried on one long shaft, supported by the two outer bearings. The prin-

Fig. 3.—Two-Bearing Motor-Generator.

Fig. 4.—Telephone Motor-Generator Set for Talking Current.

cipal advantage of this form of construction is in its compactness, and it will be found a suitable piece of machinery for use in localities where space is extremely limited.

Modern telephone practice involves the using of electric current in many different ways, and in such considerable quantities that a power plant of quite large dimensions is sometimes necessary. While the individual units are not large, they must be of considerable number, in order to furnish current of the different characteristics required. In central energy systems current is used for two purposes, namely, to supply the talking circuits and to perform the function of signaling. Direct current is used for the transmitter circuit, and this current is usually taken from a set of storage batteries, the batteries offering an ideally quiet service. Attempts have been made very often to use the current from a dynamo for the talking circuit, but the transmitters were so sensitive that the noises made by the machine were introduced, rendering articulation almost impossible. The Holtzer-Cabot company has had on the market for some time a line of dynamos of special construction, designed to generate current sufficiently smooth and noiseless to be used directly on transmitter circuits. A set of this description is shown in Fig. 4. In this instance the set is driven by a direct-current motor. The construction of these sets is such that all magnetic influences are eliminated, while the mechanical noises are taken out by means of a choke coil. This choke coil further serves to smooth out the undulations of the current, making it approach more nearly to an absolutely continuous current, such as that given by the storage battery.

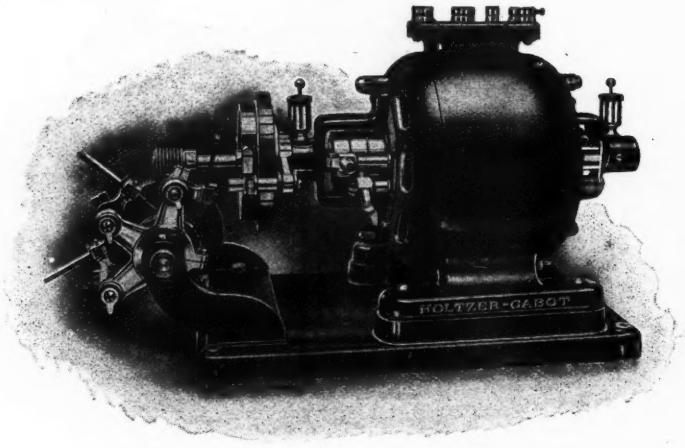


FIG. 5.—MACHINE FOR PARTY-LINE RINGING.

For signaling, more complex arrangements are necessary. The calling of the subscribers is effected by means of a low-frequency alternating current, supplied by a machine such as that shown in Fig. 2, while signals at the power board are made by means of miniature incandescent lamps and relays which are energized by current from the same source as that which supplies the transmitters. In party-line systems, it is becoming the custom to ring up subscribers selectively—that is, to signal the subscriber whose attention is desired without disturbing the bells of the other subscribers on that line. This is sometimes done by using in connection with the low-frequency alternating current, pulsating currents, which are used with bells of special construction, and respond only to pulsating waves. A set with an attachment of this kind is shown in Fig. 5. It will be seen that a split ring is attached outside the two collector rings. This is connected to the winding in such a way that half of each wave on either side of the zero line may be used as required. Thus, the operator is able to secure from the dynamo a uniform succession of electrical waves, which are disconnected but in one direction, and either plus or minus, as desired.

Another party-line system which is becoming very prominent employs motor-generators delivering current at different frequencies. One of these machines is shown in Fig. 6. This is a multi-cycle ringing set of 150 watts capacity. The set consists of a motor, driving generators of two, four, six and eight poles, giving currents of four frequencies. The speed governor is shown at the right, and the purpose of this is to hold the speed of the combination constant, by cutting resistance in and out of the motor field.

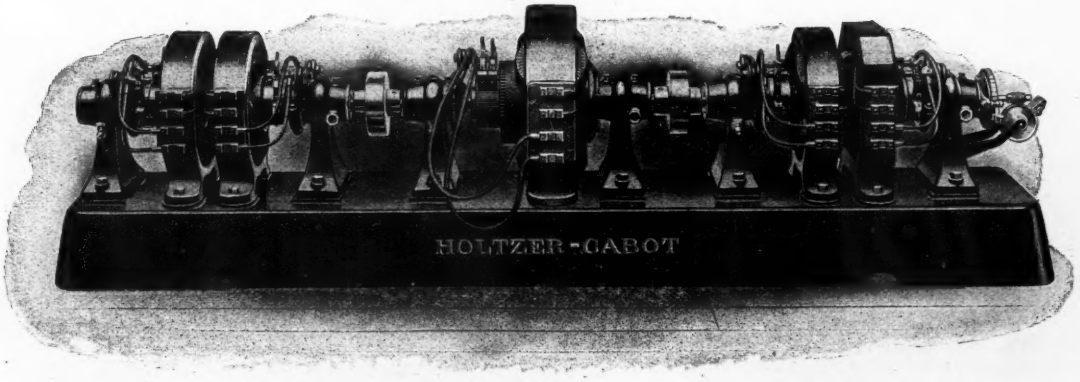


FIG. 6.—MULTI-CYCLE RINGING SET.

A New Type of Carbon Brush.

A new type of carbon brush has been invented by Herr Gisbert Kapp, for use on continuous-current dynamos. The object of the brush is to present a constant resistance of contact during the reversal of the current in the armature. This is accomplished by slitting the brush at the heel in a direction parallel to the commutator segments. The front part of the brush is solid. This construction not only reduces the variations in resistance in the contact, but increases the resistance of contact.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

INDEPENDENT TELEPHONE COMPANY GETS RIGHT OF WAY IN CINCINNATI—The Probate Court, Cincinnati, Ohio, on May 27, decided that the Queen City Telephone Company was entitled to the use of the streets of Cincinnati for its wires. The decision prescribes the manner in which the franchise should be exercised.

INTERBOROUGH SUBWAY SYSTEM SEEKING AN OUTLET—Trackage rights on the New York & Putnam Railroad are being sought by the Interborough Rapid Transit Company. Should they be obtained, electric trains may make a continuous trip, following the completion of the subway, from the Battery to Yonkers. The Putnam road consists of two branches, one running to Yonkers and the other to Mahopac Falls.

WIRELESS TELEGRAPH SYSTEM FOR ICELAND—Iceland has been more or less cut off from communication, except by slow mail, from the rest of the world. The Icelandic parliament at its last session voted a yearly subsidy of $9,380 for twenty years, for the purpose of establishing wireless telegraphic connection with the mainland of the United Kingdom or the Shetland Islands, as might seem best. Similar means of communication are to be established between Reykjavic and the principal towns of Iceland.

NEW TROLLEY SYSTEM FOR BALTIMORE, MD.—The Maryland Electric Railways Company is again seeking the right to operate a street railway line in Baltimore city. An ordinance granting the company authority to lay tracks on streets in every section of the city has been introduced in the second branch of the city council, and referred to the committee on city passenger railways. It is stated that the passage of the ordinance would mean the expenditure of $6,000,000 to $8,000,000 in Baltimore for construction, street paving and other work.

AN INTERESTING MUNICIPAL SUIT—The United States Supreme Court, in an opinion by Justice Holmes, delivered on May 31, in the case of Shaw, trustee of the Covington (Ky.) Electric Light Company, *versus* the city of Covington, decided in favor of the city. The case involved the right of the city to erect a lighting plant of its own, notwithstanding it had granted an exclusive franchise to the Covington company for twenty-five years. The court held that, in view of the fact that the company had consolidated with another company, the contract in the charter was not binding.

NEW CABLE TO GERMANY COMPLETED—The laying of the second German cable from Borkum to New York, by way of the Azores, was completed on Wednesday, June 1. The cable was laid by the steamer Stephan, which left New York on May 10 with 2,100 nautical miles of cable on board. The cable ship began to pay out on May 11, from a point off Fire Island. The shore end, between Fire Island and Coney Island, where the American end of the cable is landed, had already been laid. The final splice was made off Fayal, in the Azores. There are now two complete cables between Germany and the United States.

TELEPHONE STATISTICS—A preliminary report on the telephone systems of the United States, issued last week by the United States Census Bureau, Washington, D. C., states that in the single year of 1902 over 5,000,000,000 telephone messages were exchanged in the United States. The report covers all commercial and mutual telephone companies. There is a total of 4,151 systems, with 4,850,486 miles of wire and 2,315,297 telephones. The subscribers number 2,127,256. The total revenue of all the companies is $86,825,536; the total expenses, $61,152,823. The dividends paid were $14,982,719. In addition to the reports obtained from commercial and mutual systems, the bureau secured reports of 4,985 independent farmers or rural lines having 49,965 miles of single wire and 55,747 telephones.

ELECTRICITY FROM REFUSE IN NEW YORK CITY—A proposition which has been talked about more or less for some time now seems probable of consummation at an early date. Street Cleaning Commissioner John M. Woodbury proposes to light several of the recreation piers, his plan being to convert the refuse which his sweepers gather into current by burning it. The city has a refuse burning plant at Forty-seventh street, New York city. The commissioner intends to put in some dynamos, the plan having already been approved. The superintendent of the incineration plant has stated that, in addition to saving a large amount of money in the final disposition of the refuse, the plant already installed is capable of operating a 250-horse-power electric service.

THE LONG ISLAND RAILROAD COMPANY TO ELECTRIFY ITS SYSTEM—Work has been started on a new power-house to be erected by the Long Island Railroad Company at Hammel's Station, near Rockaway Beach, Long Island. The plans for the station call for a two-story brick structure, 69 by 85 feet, with an extension 62 by 100 feet. The estimated cost of the building is $40,000. This is the beginning of the company's plans for electrifying the entire route between Long Island City and Brooklyn and Rockaway Beach. Another substation is to be built at Woodhaven Junction. The contracts for the construction of these buildings call for completed structures by January 1, 1905. The entire Long Island system west of Jamaica, on the Atlantic Avenue and Rockaway division, will be operated by electricity next year.

EXTENSIVE ELECTRIC TRACTION SYSTEM FOR BIRMINGHAM, ENGLAND—A municipal electric traction, light and power system is to be installed in Birmingham, England, at an estimated cost of $3,000,000. It is proposed to acquire the existing tramways, operated by private concerns, and to extend these. The lighting and general power facilities in and around Birmingham—which is one of the most important commercial centres in England—are also to be acquired and extended. The tramways already built have a length of about thirty miles. The ultimate capacity of the central power station which is to be erected will be about 33,000 horse-power. For the outlying districts, six substations will be built. There will be thirteen transformer sets of 300 kilowatts capacity each. These will include rotary converters, static transformers, regulating appliances, and switchboards and storage batteries.

MEXICAN ELECTRICAL NOTES—The company recently organized for the purpose of installing an electric power plant on the Naranja river, state of Colima, has acquired the street railway system in Colima, consisting of some six miles of track. The company will make important extensions and improvements. Arrangements are being made for the construction of canals to carry the water of the Naranja river to the site of the proposed power plant. The water will have a fall of 400 feet, and it is estimated that at least 1,500 horse-power can be developed. Current will be transmitted to Colima, over a distance of fifteen miles. This power plant will also be utilized to supply current for lighting the city of Colima. Messrs. Ugarte & Garcia, of Guadalajara, who will build the above mentioned plant, have also a contract for installing an electric light plant at Colima, to cost $150,000. Work on this plant will soon be commenced, and it is understood that the equipment will be purchased in the United States.

ELECTRIC LIGHTING.

CROOKSTON, MINN.—A municipal electric light plant will be installed at Thief River Falls this summer.

DANVILLE, VA.—The new municipal electric lighting plant has been placed in operation. The total cost was about $9,500.

WICKLIFFE, KY.—The city council has let the contract for the electric light plant to R. E. Gannon, of Cairo, for the sum of $6,042.

SALIDA, COL.—The city council has awarded a four-year contract for street lighting to the Chaffee County Electric Light and Power Company.

FREDERICK, MD.—The Frederick Electric Light and Power Company, of Frederick, has been sold to the Frederick Gas Company, which is owned by a syndicate of Philadelphia capitalists. It

is said that the two plants will in the future be operated under one management.

FORT MADISON, IOWA—Samuel Atlee has purchased the Wood twenty-five-year franchises for gas and electric lighting, steam heating and interurban railway.

HOPKINSVILLE, KY.—Fire recently destroyed the plant of the Hopkinsville Gas and Lighting Company, which furnished electric light to the city. The loss was $30,000.

ALBANY, N. Y.—A certificate has been filed with the secretary of state of the merger of the Municipal Gas and Electric Company with the Rochester Gas and Electric Company.

SPRINGFIELD, MO.—It is stated that the Ash Grove Lime Works is arranging to install an extensive electric plant, of a capacity sufficient to run all branches of the work.

SCHOOLCRAFT, MICH.—The power-house of the village municipal electric lighting plant has been destroyed by fire. The loss on machinery and building is $7,000, with $5,000 insurance.

GOSHEN, IND.—The St. Joseph & Elkhart Power Company, which operates the dam and power-house at Hen Island, will erect a second dam on the St. Joseph river at Bristol, Ind., or Berrien, Mich.

WEST CHESTER, PA.—Sealed proposals for street lighting will be received by the chairman of the light committee until June 30, to light the streets of Downington for a period of one, three or five years.

ALAMEDA, CAL.—The monthly financial report of the municipal electric light department shows total expenses for April to have been $2,206.39, and the earnings, $1,222.95. The earnings are about $300 in excess of those of the corresponding period of last year.

REDDING, CAL.—It is stated that the construction of the new power plant on Bear creek is a certainty, and that operations will be commenced at once. Harry L. Shannon, who is at the head of the enterprise, states that the plant will be in operation by January 1.

BATAVIA, N. Y.—The Le Roy Hydraulic Electric-Gas Company has filed a formal notice with the county clerk of its intention to increase its capital stock from $65,000 to $100,000. The money received from the sale of this stock, it is stated, will be used in making extensive improvements.

SANTA CRUZ, CAL.—Articles of incorporation of the Watsonville Light and Power Company have been filed with the county clerk. The stockholders are Fish M. Ray, Oakland; Joseph C. Love, Berkeley; David H. Foote, San Francisco; Charles W. Waller, San Francisco; A. W. Linforth, San Francisco.

INDIANAPOLIS, IND.—The board of public works will begin at once the location of the additional electric lights to which the city is entitled under the new contract. The minimum number under this contract is 1,600, and 262 new lights will have to be added to the present number to reach this limit.

WHEELING, W. VA.—The Bellaire Light and Power Company has made arrangements for the expenditure of about $75,000 in the improvement of its plant during the summer. A 450-horse-power engine and a 300-kilowatt generator will be installed and the present wire will be replaced by a heavier copper strand. The work will be started at once and pushed to an early completion.

KEY WEST, FLA.—The Key West Electric Light Company has absorbed the Electric Light and Power Company. For the present both of the plants will be operated. New machinery has been ordered, and as soon as it is installed the power will be furnished from the Key West plant. When the work is completed, about half of the wires will be cut out and half of the poles removed from the city streets.

CAMDEN, N. J.—By the terms of the new lighting contract made between the city and the Public Service Corporation, the city saves $5,502 yearly, or $27,510 in the five years that the contract is to run. The price for arc lamps will be thirty cents per night per lamp, or $109.50 a year. The price in the contract now expiring is $120. There are 524 arc lights in the city. The price for incandescent lamps will remain the same—$20 per lamp per year.

HARRISBURG, PA.—The United Electric Company has begun the enlargement of its plant at Riverton for the purpose of installing a perfectly new outfit of machinery for the generating of electricity. The company operates practically all the trolley lines between Harrisburg and Mechanicsburg, and, in addition, furnishes electric light to Riverton, Enola, Fairview, Wormleysburg, New Cumberland, Lemoyne, Camp Hill, Shiremanstown and Mechanicsburg.

FORT WAYNE, IND.—President John W. White, of the Fort Wayne Electric Light and Power Company, announces that the company's plant has been sold to eastern capitalists for about $500,000. The syndicate which bought the plant is headed by Thomas Wanamaker, of Philadelphia, and will, it is stated, also purchase the Fort Wayne traction lines and the bulk of the interurban connections, which have recently been merged under the name of the Fort Wayne & Wabash Valley Traction Company.

ALBION, N. Y.—The Albion Power Company has a large number of men at work on its new power site at Clark's Mills. The old dam is to be rebuilt and its height to be increased about two feet. A power-house is to be erected and a water-wheel installed. It is the intention of the company to raise the dam at Waterport about fifteen feet, which will keep the water back up the creek and thus create a large storage pond. The Albion and Brockport plants, owned by the company, will make use of the power generated at Waterport and Clark's Mills.

EASTON, PA.—The superintendent of the city electric light plant has submitted his annual report to the city council, which shows that the cost per lamp per year was $66.50. There are 220 high-tension, double-carbon, 2,000-candle-power arc lamps connected with the plant, and thirty miles of insulated copper wire are used. Each of these lamps burned a total of 3,973 hours during the year, an average of ten hours and twenty minutes a night. The cost of each lamp per night was 18.1 cents. The recommendation is made that an additional 100-light dynamo be installed.

MECHANICSBURG, PA.—It is announced that sealed proposals will be received until 12 o'clock, noon, July 1, 1904, for the lighting of the streets of the borough of Mechanicsburg, Cumberland County, Pa., by electricity, as follows: by fifty or more arc lights 1,600 candle-power, and thirty-five or more incandescent lights thirty-two candle-power to burn every night and all night; by fifty or more arc lights 1,600 candle-power, and thirty-five or more incandescent lights thirty-two candle-power to burn every night until 12 o'clock. Both bids to be on a one-year contract from September 1, 1904, allowing the borough the privilege of renewing the contract annually for two years additional.

PERSONAL MENTION.

MR. J. W. TAYLOR, of El Paso, Tex., is reported to be interested in a project to build a large electric light and power plant at Guaynopita, state of Chihuahua, Mexico.

MR. R. JOHIKAWA, who is chief electrician of the Japanese army, accompanied by some of his countrymen, recently inspected in detail the electric plant at the dam of the Hudson River Power Company, at Spier Falls, N. Y.

MR. DEXTER S. KIMBALL has been appointed professor of mechanic arts, in charge of the Sibley shops, Cornell University, Ithaca, N. Y. Professor Kimball succeeds Professor J. L. Morris, who, after continuous service since 1868, will become professor emeritus.

MR. W. J. DAVIS, JR., who is connected with the General Electric Company, Schenectady, N. Y., attended a meeting of the New England Street Railway Club held at the Revere House, Boston, Mass., recently and read an able and interesting paper on "High-Tension Transmission as Applied to Electric Railways."

MR. J. G. ROSSMAN, who has been active in the electrical field for some time past, and who has been successful in planning many large electrical plants in different parts of the country, has opened an office in the Peters Building, Atlanta, Ga., where he will make a specialty of the planning of electrical plants and in giving expert advice in matters of electrical equipment.

MR. C. C. TYLER has been appointed general superintendent of all the works of the Allis-Chalmers-Bullock interests in the United States. He enters his new duties on June 15, making his headquarters at Milwaukee, Wis. Mr. Tyler has resigned as superin-

tendent of the works of the Westinghouse Electric and Manufacturing Company, at Pittsburg. Mr. Tyler has had a wide experience in the equipment of manufactories, in the design and construction of machine tools, in the handling of machinery and material, and in the process and manufacture and economy of machine-shop installation.

MR. MAX LOEWENTHAL, electrical engineer of the Prometheus Electric Company, 60 Reade street, New York city, has returned from a four months' trip throughout the United States. Mr. Loewenthal reports a greatly increasing interest in the matter of electric heating. The Prometheus company is one of the pioneers in the production of heating and cooking apparatus and novelties utilizing electric currents for the production of heat.

MR. A. E. WORSWICK, formerly chief engineer of the Mexico City electric traction system, which is equipped with American power-house apparatus, has been appointed consulting electrical engineer to the British contracting firm of S. Pearson & Son, Limited, whose president, Sir Weetman D. Pearson, is interested in various electrical projects in the southern republic, notably the pending conversion of the Vera Cruz tramways into electric motive power.

MR. H. A. BELDEN, who is the general manager of the Manila Electric Railroad and Lighting Company, an American concern which is building a traction system in the Philippines, is reported to be on his way to New York city. While in New York Mr. Belden will make his headquarters at the offices of the electrical engineering and contracting firm of J. G. White & Company, 49 Exchange place, which concern has the contract for the construction and equipment of the system.

MR. PAUL M. MOWREY, who for some time past was connected with the Merchants' Trust Company, as adviser on industrial investments, has been made vice-president of the Engineering Company of America, New York city, N. Y. Mr. Mowrey has been prominently identified with the engineering and contracting business for many years past—since he became connected with the Edison Electric Illuminating Company. Among the numerous successful enterprises carried out by Mr. Mowrey was the purchase and consolidation of the street railway and power companies of Richmond, Va., which were later turned over to Mr. F. J. Gould.

MR. CHARLES DAY gave an interesting and instructive lecture on "The Modern Machine Shop" before a large audience at the Carnegie Music Hall, Pittsburg, Pa., Monday evening, May 16, under the auspices of the Carnegie Technical School. The address took up the early history of the machine shop and the work done by such pioneers as Watt, Maudslay, Nesmyth and Whitworth. Some of the original machines designed by these gentlemen were discussed and illustrated. The evolution up to the present day was traced through its various stages and illustrated by lantern slides. Mr. Day, who is the well-known engineer of the firm of Dodge & Day, Philadelphia, Pa., was introduced by Mr. Frank H. Taylor, vice-president of the Westinghouse Electric and Manufacturing Company.

OBITUARY NOTICE.

MR. JAMES A. MYERS.

MR. JAMES A. MYERS, president and treasurer of the Robbins & Myers Company, Springfield, Ohio, died at his home in Springfield on May 27, 1904. Mr. Myers was born at Jamestown, Ohio, in 1851, and was educated at Bowersville Academy. In 1876 he went to Springfield, Ohio, to engage in business, and in 1878 he became interested with Mr. Robbins in the iron foundry business, forming in 1889 the present Robbins & Myers Company. In 1896 he became actively interested in electrical affairs and the company entered the electrical manufacturing field. From this time his acquaintance among members of the electrical fraternity rapidly increased, until at the time of his death he was well known in all sections of the country. In 1900, when Mr. Robbins retired from the presidency of the company, Mr. Myers was made president, which position he held until his death. Mr. Myers leaves a wife and two sons.

ELECTRICAL SECURITIES.

The general contraction in business, which has spread rapidly throughout the country, is becoming more apparent each succeeding week. As has been pointed out before, this condition is not one to cause undue apprehension, but is rather an evidence of a sane understanding of the business necessities of the times. Conserving finances and an effort to get clear of the aftermath of an excessive production is the characteristic effort now being made in commercial circles. In the West there is noticeable a disposition to cut out a steady pace for business movements, and no little amount of enthusiasm will be necessary to induce a change for some time to come. It seems peculiar that after being ignored for some time, due to the great success of the mechanic arts, the agricultural factor is now one of the most important. Weather conditions, which have no effect on shop or forge, are now watched with the keenest interest and concern. Altogether, it looks as though the farmer was once more to become the financial barometer. Looking into the local stock market last week, it seems possible that a decline would have been in order were it not for the hope that the crop outlook would conduce to better values. However, there has been of late so little activity that prices change in fractions whether the outlook is good or bad.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JUNE 4.

New York:	*Closing.*
Brooklyn Rapid Transit	46⅞
Consolidated Gas	203
General Electric	155
Kings County Electric	188
Manhattan Elevated	144
Metropolitan Street Railway	110
New York & New Jersey Telephone	143
Westinghouse Manufacturing Company	180

Stockholders of the Consolidated Gas Company have ratified the proposition of the directors to increase the capital stock from $80,000,000 to $100,000,000, in connection with issuing $20,000,000 debenture bonds, convertible into stock after three years. The increase in capitalization was unanimously ratified. The vote cast represented 555,479 shares, or 69 per cent of the total capital outstanding.

A quarterly dividend of 1¼ per cent on the capital stock of the Manhattan Railway Company will be paid on and after July 1, 1904, to stockholders of record at the closing of the transfer books on June 10. The transfer books will be reopened Wednesday, June 22.

Boston:	*Closing.*
American Telephone and Telegraph	125
Edison Electric Illuminating	234
Massachusetts Electric	69½
New England Telephone	121
Western Telephone and Telegraph preferred	77

The New England Telephone Company will issue 30,881 shares of stock at par. Each stockholder of record June 18 will be entitled to one new share for every seven shares then held. The right to subscribe will expire at the close of business July 16.

Philadelphia:	*Closing.*
Electric Company of America	8⅛
Electric Storage Battery common	57
Electric Storage Battery preferred	57
Philadelphia Electric	6⅜
Union Traction	49⅞
United Gas Improvement	81¾

Chicago:	*Closing.*
Chicago Telephone	118
Chicago Edison Light	143
Metropolitan Elevated preferred	51
National Carbon common	28
National Carbon preferred	101½
Union Traction common	5½
Union Traction preferred	29

South Side Elevated directors have declared the regular quarterly dividend of 1 per cent, payable July 1. Books close June 20 and reopen July 1. A stockholders' special meeting has been called for August 9, to authorize an issue of $8,000,000 4½ per cent bonds.

Northwestern Elevated for May had a daily average number of passengers of 69,232, an increase of 2,242.

NEW INCORPORATIONS.

FRANKFORT, KY.—Hyden Telephone Company. $3,000.

COLUMBUS, OHIO—Seneca Telephone Company. $20,000.

LENEXA, KAN.—Interstate Telephone Company. $7,500.

MOBILE, ALA.—Southern Construction Company. $30,000.

WEST UNION, IOWA—Rogers Telephone Company. $25,000.

AUSTIN, TEX.—The Gertie Webb Telephone Company. $20,000.

WEST UNION, IOWA—The Rogers Telephone Company. $25,000.

CONESVILLE, IOWA—The Conesville Telephone Company. $10,000.

JACKSON, MISS.—The Smith County Telephone Company. $5,000.

ALBANY, N. Y.—The Ravena & Medway Telephone Company. $5,000.

PETERSBURG, IND.—The Stindal Home Telephone Company. $20,000.

JERSEY CITY, N. J.—The Commonwealth Electric Company. $100,000.

FRANKFORT, KY.—The Pineville Electric Light and Ice Company. $25,000.

CALDWELL, OHIO—Caldwell Independent Telephone Company. Increased to $50,000.

BELLEFONTAINE, OHIO—The United Telephone Company. Increased to $300,000.

MANLIUS, MO.—The Bureau County Mutual Telephone Company. Increased to $20,000.

TROY, N. Y.—The Commercial Union Telephone Company. Increased from $10,000 to $800,000.

JERSEY CITY, N. J.—The Municipal Lighting Company. Reduced from $500,000 to $100,000.

AMSTERDAM, N. Y.—The Amsterdam Automatic Telephone Company. Increased from $15,000 to $100,000.

INDIANAPOLIS, IND.—Waupecong Home Telephone Company. $10,000. Directors: Jonas Stineman and others.

PULLMAN, ORE.—Crumbaker Telephone Company. $10,000. Incorporators: M. Crumbaker, Burt Gray and T. Neill.

DES MOINES, IOWA—The Farmers' Connecting Telephone Company. $10,000. President, J. W. Batchelor, of Bentonsport.

NOBLESVILLE, IND.—The Baton Rouge Telephone Company. $2,000. Directors: C. D. Zimmer, J. W. Aldred and S. Morrison.

COLUMBUS, OHIO—The Gilbert Telephone Company. $2,000. Incorporators: E. L. Roe, H. L. Nye, W. M. Bateman and others.

HARRISBURG, PA.—Spangler Electric Light, Heat and Power Company; $5,000. Hendrick Light and Power Company; $5,000.

JOHNSTON CITY, ILL.—Johnston City Telephone Company. $8,000. Incorporators: C. E. McClintock, W. A. Roberts, J. E. Carr.

SEYMOUR, TEX.—Proffitt Telephone Company. $40,000. Incorporators: J. W. Proffitt, W. L. Payne, W. E. Bailes, John H. Proffitt.

SONORA, CAL.—Central California Electric Company. $500,000. Directors: B. F. Eastman and M. J. Gardner, of Stockton, and others.

MILWAUKEE, WIS.—The Stevens Point Power Company. $100,000. Incorporators: William Mainland, A. E. Thompson and H. C. Jenkins.

EVERETT, WASH.—The Snohomish & Cherry Valley Electric Railway Company. $1,200,000. Incorporators: E. Colburn and Fred S. Anderson.

DENVER, COL.—Cottonwood Light and Power Company. $100,000. Incorporators: F. R. Marsh, E. J. Knight, F. G. Peck and W. J. Chinn.

DENVER, COL.—The Consumers' Electric Company. $50,000. Incorporators: James H. O'Hern, Frank Hamilton, Louise O'Hern, Louisville, Col.

MADISON, WIS.—Mondovi Telephone Company. $240,000. Incorporators: B. S. Lockwood, G. A. Luetscher, S. D. Hubbard and C. W. Gilman.

ALBANY, N. Y.—Edmeston Light, Heat and Power Company. $6,000. Incorporators: Charles T. Coats, Homer Underwood, C. W. Hopkins, of Edmeston.

ST. LOUIS, MO.—The Ada Electric Light and Power Company. $40,000. Incorporators: Charles L. Patterson, Allen B. Patterson and William F. Klanke.

TROTWOOD, OHIO—Trotwood Home Telephone Company. $10,000. Incorporators: G. W. Minnick, W. Swinger, J. Lambs, S. A. Blessing and W. L. Basher.

TRAVERSE, MINN.—The Farmers' Cooperative Telephone Company. $12,000. Incorporators: J. H. Miller, C. L. Nelson, E. B. Rounsville and F. E. Briggs.

CAIRO, N. Y.—Round Top, Purling & Cairo Telephone Company. $400. Incorporators: William L. Richards, Joseph Richards and James B. Edgerly, all of Cairo.

BOSTON, MASS.—Mattapan Gas and Electric Light Company. $10,000. Directors: John H. Doherty, Edward W. Ryan, Nathaniel G. Robinson and James F. Ryan.

ALBANY, N. Y.—The Allysses Cooperative Telephone Company. $7,200. Incorporators: W. Mikeel, A. H. Wood, Jacksonville, N. Y.; F. W. Carman, Trumansburg, N. Y.

MOUNT VERNON, IND.—The Mount Vernon Electric Light and Power Company. $5,000. Directors: J. H. Purdy, H. B. Rhine, G. E. Hoffmaster, R. D. Morris, G. L. Menzies.

LITTLE ROCK, ARK.—The Lewisville Light and Water Company. $25,000. Incorporators: E. B. Daniel, G. W. Dobson, J. W. Miller, W. D. Stewart and A. H. Hamiter.

COLUMBUS, OHIO—The Bedford Electric Light and Power Company. $50,000. Incorporators: E. E. Mandeville, Edward Roberts, Stanley E. Smith, Howard A. Crouse and Ira M. Eaton.

GREENVILLE, OHIO—The Eldorado & West Manchester Telephone Company. To build and operate telephone lines at West Manchester and Eldorado, Preble County, and in the surrounding territory. $40,000. Incorporators: C. R. Lefturich and others.

SANTA MARIA, CAL.—Santa Maria Power and Lighting Company. $50,000. Directors: H. T. Duff, W. F. Gibbs, R. H. Pallard and F. G. Armstrong, of Los Angeles, and B. E. Page, of Pasadena.

OSSEO, MINN.—Rural Telephone Company. $50,000. Incorporators: Henry Benning, E. F. Hecklean, H. E. Punt, Eden Schmidt, Elmer Owen, A. P. Atchtman, D. V. Dibb, R. F. Goetze and C. E. Evans.

ALBANY, N. Y.—The Kings County Lighting Company. $2,000,000. Directors: Ashley T. Cole and Charles T. Lark, of New York city; William J. Bagnell, of Bayonne, N. J.; Alex Keogh, of New Rochelle, and W. R. Fuller, of Brooklyn.

HARRISBURG, PA.—Philadelphia & Garrettsford Street Railway Company; to build one mile of road on the Garrett road in Upper Darby township; $6,000. Philadelphia & Darby Creek Street Railway Company; to build one mile of road over the state road in Upper Darby township; $6,000.

TRENTON, N. J.—The New Jersey Short Line Railroad Company. To build a trolley line from New Brunswick to Elizabeth. $3,000,000. Incorporators: Richard D. Ashbridge, East Downington, Pa.; Thomas P. Phillips, Abraham A. Moyer and Thomas R. Heller, of Philadelphia, and Thomas P. Curley, George H. B. Martin and John H. Semple, of Camden.

SALT LAKE CITY, UTAH—The Pan Power and Electric Company of Utah; $10,000; president, William D. Cameron, New York city; vice-president, William M. Bradley, Salt Lake City; secretary and treasurer, James A. Mahon, Salt Lake City. Millard County Telegraph and Telephone Company; $6,000; Thomas C. Callister, president; A. M. Callister, vice-president, and T. C. Callister, secretary and treasurer.

ELECTRIC RAILWAYS.

CLINTON, IOWA—The Iowa & Illinois Interurban Railway Company, which is building the line between Clinton and Davenport, has decided to locate its shops, power-house and offices in Clinton.

JAMESTOWN, N. Y.—The town of Carroll has granted a formal franchise to the Jamestown-Warren Traction Company to lay its lines along the highway between the villages of Frewsburg and Fentonville.

DETROIT, MICH.—Preliminary plans are being made for a new electric line between Detroit and Adrian, projected to run through the towns of Taylor Center, Romulus, Belleville, Milan and Tecumseh, a distance of sixty miles.

ST. LOUIS, MO.—Plans are being perfected for building an electric line from St. Louis to Alton, to be backed by the syndicate owning the Alton Light and Traction Company. The line will connect with the Alton system.

EAST ST. LOUIS, ILL.—The Omaha, Lincoln & Beatrice Railroad, the new electric line projected between the cities named, has filed an amendment to its articles of incorporation, increasing its capital stock from $200,000 to $2,250,000.

SPRINGFIELD, MO.—The Western Traction Company, of Indianapolis, has commenced a survey between Springfield and Carthage for a new electric railway, which it declares will be rushed through. The road will be standard gauge and will handle passenger and freight traffic.

WABASH, IND.—At a meeting of the Wabash Exchange, to organize and to assist the construction of the Wabash-Warsaw trolley line from North Manchester to Wabash, assurance was given by Dayton capitalists that the road would be built this summer, either by way of Laketon or Urbana.

AUSTIN, TEX.—The charter of the Belton-Temple Traction Company, with principal office at Temple, has been filed in the secretary of state's office. Its capital stock is $250,000, and it is formed for the purpose of constructing and operating a line of electric road between Belton and Temple, Tex.

FORT COLLINS, COL.—The city council has approved of an ordinance granting an electric street railway franchise to the Northern Colorado Electric Railway Company. The ordinance provides that construction work on the line or lines must be commenced within one year and the railway completed within two years.

LEBANON, PA.—The Philadelphia, Lancaster & Harrisburg Railway Company has decided to extend its lines to this city. The extension is to be built from a point on the Lancaster, Elizabethtown & Middletown turnpike road in Mount Joy township, Lancaster County, passing through Bellaire, Lawn, Mount Gretna and Bismarck, Lebanon County, to the centre of this city.

DANVILLE, PA.—The Danville & Bloomsburg Electric Railway Company has started work on its line, which will extend from Danville to Bloomsburg, a distance of ten miles. The company expects to have it completed by September. As soon as the bridge over the Susquehanna river is rebuilt the line will extend to South Danville and thence to Snydertown, where it will connect with the proposed Shamokin and Sunbury line.

NEW LONDON, CT.—The survey for the trolley line which the East Lyme Street Railway Company is to build in the towns of New London, Waterford and East Lyme is nearly completed. The road will be about eleven miles long, and the cost of construction is roughly estimated at about $235,000. No power plant will be erected, as arrangements have been made to obtain power from the station of the New London Street Railway Company.

ANDERSON, IND.—The stockholders of the Anderson Traction Company have elected the following directors: J. A. Brock, Dr. George E. Coughlin, S. M. Orr, J. J. Fretwell, R. S. Hill, B. F. Mauldin, R. E. Ligion, G. A. Ledbetter, Fred G. Brown, W. F. Cox, D. P. McBrayer and C. S. Sullivan. The directors elected the following officers: J. A. Brock, president and treasurer; F. G. Brown, vice-president; Dr. George E. Coughlin, general manager.

LANCASTER, PA.—Work has commenced on the line of the Philadelphia, Coatesville & Lancaster Railway Company, which will complete a system of trolley roads uniting this city and Philadelphia. Grading between Christiana and Coatesville is being pushed rapidly, and poles and rails are distributed over half the line. It is expected that within another year through cars will be in operation between Philadelphia and Lancaster, by way of West Chester, Coatesville, Parkesburg, Christiana, Paradise and Strasburg, connection being made at the latter point with the road to this city.

MINNEAPOLIS, MINN.—The Pioneer Electric Railway Company, capital $100,000, has filed articles of incorporation in St. Paul. The paper designates a line from White Rock, Minn., to the Twin Cities, or across the state, but the present plan is to build only from White Rock to Cannon Falls, a distance of twelve miles. P. M. McAllister, of Minneapolis, is president of the company, and the other officers are: H. S. Johnson, F. D. Woodbury, E. L. Fischer, all of Minneapolis, and A. W. Holmes, of St. Paul.

ALBANY, N. Y.—The Rochester & Eastern Rapid Railway Company has been granted approval by the state railroad commission of an application to increase its capital stock from $500,000 to $1,500,000. The Peekskill Lighting and Railroad Company to increase from $500,000 to $650,000. The Auburn & Syracuse Electric Railroad to increase from $1,300,000 to $1,500,000. The Orange County Traction Company has been given the commission's consent to issue a mortgage for $100,000.

NASHVILLE, ILL.—Construction on the Illinois Southern electric railway is now well under way and it is expected to have the roadbed in shape for the laying of track by the middle of July. The line will extend from Okawville, in this county, through Venedy, New Memphis and Mascoutah, and thence on to Belleville, to connect with the Suburban line for St. Louis. Later it is proposed to extend the line to Mount Vernon through the intermediate towns. Franchises along this proposed extension have been secured.

WEST CHESTER, PA.—For the purpose of establishing faster running time between the terminals of the trolley road, the officials of the West Chester & Philadelphia Traction Company are securing rights of way along the present route, with the purpose of eliminating a number of curves and grades. The trip is now made in seventy-two minutes, but with the straightening of the line and an improved roadbed, the schedule time between West Chester and Sixty-third and Market streets, Philadelphia, may be fixed at fifty minutes.

FREDERICK, MD.—The burgess and council of the town of Myersville, this county, have granted to the Hagerstown Electric Railway Company a franchise which will permit the company to run the railroad, which is to connect the trolley lines in Frederick and Washington counties, through the main street of the town. This practically completes the negotiations for the building of the road, and the railway officials assured the Myersville council that it will be completed and in operation before the agricultural fairs in Frederick and Hagerstown next fall.

INDIANAPOLIS, IND.—The Portland, Montpelier, Warren & Huntington Railway Company, with a capital stock of $15,000, has been incorporated with the secretary of state. The company proposes to operate an electric railway running between and within the cities of Portland, Montpelier, Warren and Huntington. The incorporators are James West, Jackson township, Wells County; Loi Huffman, Salamonie; D. A. Williamson, Chester township, Wells County, and Thomas H. Bradstreet, D. A. Bryson, W. E. Sinclair and Scott Mills, of Montpelier. The principal place of business of the corporation will be at Montpelier.

LEBANON, PA.—At a meeting at Palmyra the plan to build a trolley line from Palmyra to Grantville, *via* Valley Glen Park, was formally launched by business men of Palmyra. The road is to cost about $60,000, and will be known as the Palmyra & Grantville Railway Company. It is to be completed as far as Valley Glen by August and the remainder of the line, three miles, to Grantville, is to be built afterward as rapidly as possible. The ten-mile stretch of Jonestown road, between Linglestown and Grantville, is being surveyed by other parties at present to connect the newly laid Harrisburg & Linglestown Electric Railway with the Palmyra & Grantville line.

AUSTIN, TEX.—Articles of incorporation of the Houston-Galveston Interurban Railway have been filed for record in the state department. The capital stock of the corporation is $250,000, and its purpose is the construction, acquiring, maintaining and operating a line of electric railway between the cities of Houston and Galveston and the right to construct branches to the towns of La Porte, Seabrook and Alvin. The incorporators are W. E. Scott, W. B. Slassom, O. M. Whitcomb and N. C. Abbott, of Houston. The directors are James R. Patton, Kansas City; Charles D. Graham, Fairview, Kan.; Walter Gresham, Galveston; O. M. Whitcomb, Webster; W. E. Scott, W. B. Slassom and N. C. Abbott, J. Edgar Lafferty, of Houston, and T. W. Allen, of Greenup, Ill.

INDUSTRIAL ITEMS.

THE WILLIAMS TELEPHONE AND SUPPLY COMPANY, 80-86 Seneca street, Cleveland, Ohio, is distributing a neat booklet giving a number of testimonials from satisfied users of the Williams telephone apparatus.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., has issued the June, 1904, number of "Graphite." This issue, as is usual with this publication, contains much interesting information in connection with the application of graphite.

THE STAR DYNAMO COMPANY, Jefferson City, Mo., is mailing a new catalogue which gives a general description and illustration of its line of direct-current dynamos and motors. These range from one-half to seven and one-half kilowatts in capacity.

THE SHELBY STEEL TUBE COMPANY, Pittsburg, New York and Chicago, is making an elaborate exhibit in the Transportation Building, World's Fair, St. Louis, Mo. A feature of this exhibit is a pagoda constructed entirely of Shelby steel tubes of various dimensions.

THE NILES-BEMENT-POND COMPANY, 136 Liberty street, New York city, N. Y., has issued the "Progress Reporter" for May, 1904. This publication contains many interesting articles, among which is a "108-Inch Bement Lathe, Electrically Driven." Copy will be sent on request.

THE EDISON ELECTRIC ILLUMINATING COMPANY, Boston, Mass., is distributing the June, 1904, number of the "Edison Light." This number contains many interesting articles and a double page half-tone engraving illustrating the company's new turbine station located in South Boston.

THE LANE & BODLEY COMPANY, Cincinnati, Ohio, is mailing a card showing the "Twentieth Century" heavy-duty Corliss engines for all purposes. On the reverse of this card there is shown a direct-connected unit built by the Lane & Bodley Company, installed in a modern generating station.

THE C. W. HUNT COMPANY, West New Brighton, S. I., N. Y., is making a complete exhibit in the Palace of Electricity at the St. Louis World's Fair. The exhibit includes industrial railways, electric locomotives, coal-handling machinery, conveyers, steam-hoisting engines, electric-hoisting engines, and manilla rope.

THE RITTENHOUSE-MILLER COMPANY, Philadelphia, Pa., manufacturer of "Eureka" flexible conduit, has removed its factory to Trenton, N. J. This will increase its facilities for the production of flexible conduit. The company states that it is now prepared to fill orders for any quantity within twenty-four hours.

THE SMITH STORAGE BATTERY COMPANY, Binghamton, N. Y., is sending out a supplement to its catalogue No. 2. This supplement illustrates and describes an installation of the company's electric storage batteries installed in the Broome County buildings in Binghamton. Supplement will be sent on request.

THE NEW ERA GAS ENGINE COMPANY, Dayton, Ohio, in a new catalogue describes and illustrates the New Era gas and gasoline engines. Half-tone reproductions are included, showing the New Era engine in assembly and in detail. A specialty which this company has introduced is the New Era portable gasoline engine.

THE ST. LOUIS EXPANDED METAL FIREPROOFING COMPANY, Century Building, St. Louis, Mo., has published a complete catalogue dealing with its corrugated steel bars, as applied to steel and concrete construction. This catalogue not only gives the weights and construction of the expanded metal, but also gives numerous illustrations of typical applications of expanded metal to construction work.

THE ELECTRIC CITY PUBLISHING COMPANY publishes a folder entitled "Electric City." The object of this publication is stated to be "to help make Chicago the greatest electric city in the world." There is a "junior section" and a "popular science section," in addition to considerable illustrated matter of an interesting nature. There is also a directory giving a great deal of information of value to parties interested in electric light and power.

THE F. W. BRAUN COMPANY, Los Angeles, Cal., is distributing a pamphlet entitled "Annealing, Hardening, Tempering and Case Hardening." In this little book there have been compiled numerous helpful hints which will be of general interest in this line of work. The booklet also tells about the advantages of the Braun portable forge and tempering furnace. The fuel used in the Braun portable forge is gasoline, which is burned in a Cary hydrocarbon burner.

THE HALLER MACHINE COMPANY, 127-129 Fulton street, Chicago, Ill., in circular No. 7 describes and illustrates a line of electric signs. This company is the designer and manufacturer of sheet metal, electric and machinery specialties. The company makes up letters for electrical signs, completely wired and mounted for connecting. All of the accessories to electrical signs are also made by this company, including sign lamps, rubber rings, automatic flashers and dimmers, motors, and automatic time switches.

THE FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind., in bulletin No. 1055 describes form C arc lamps with concentric diffusers for interior lighting. These equipments are especially adapted for lighting establishments where textiles are handled, as the quality of light is just what is desired for this service. The Fort Wayne company is also mailing a flyer giving the connections of alternating-current, 104-volt, form C arc lamps, and an attractive catalogue detailing the summer comforts possible with "Wood" fan motors for 1904.

THE AUTOMATIC ELECTRIC COMPANY, Chicago, Ill., extends a cordial invitation for every one interested to visit its headquarters at the Louisiana Purchase Exposition, section 24, Palace of Electricity. A large working exhibit of Automatic telephone apparatus is installed, and two complete switchboards are in constant operation. Visitors will be courteously received and given an opportunity to acquaint themselves with this system, which has been adopted very successfully in a number of cities and towns of the United States.

THE UNION METALLIC CARTRIDGE COMPANY, Bridgeport, Ct., is installing Westinghouse-Parsons steam turbines in its new power station. The initial installation will consist of two turbo-generating units, each of 500 kilowatts capacity. The two units will operate in parallel, and will furnish 440-volt three-phase current at 7,200 alternations per minute. This current will be for general power and lighting purposes in the various shops located within three or four blocks of the power station. The turbines will operate under 150 pounds of steam, with twenty-eight inches vacuum, and possibly superheat.

THE LOCKE INSULATOR MANUFACTURING COMPANY, Victor, N. Y., made an exhibit at the recent convention of the National Electric Light Association at Boston in connection with its New England agents—the Pettingell-Andrews Company—which was of especial interest to electrical engineers and central station managers, inasmuch as an almost complete line of the Locke insulators was on view, and especially types of the high potential insulators for electric light work. This company publishes an excellently illustrated catalogue descriptive of insulators for all applications, which will be sent on request. The company is also making a comprehensive exhibit at the Electricity Building, St. Louis Exposition.

THE ARNOLD ELECTRIC POWER STATION COMPANY, Chicago, Ill., has begun construction work on the hydroelectric plant to be installed near Lowell, Kan., for the Spring River Power Company. The Arnold company has been retained as engineers and constructors for the entire equipment, including dam, power-house, water-wheels, transformer houses and high-tension transmission line along with the electrical equipment. The dam, power-house and controlling works are to be built of concrete and steel construction. At present eight pairs of turbine wheels are to be installed, aggregating 5,600 horse-power. These are to be direct-connected to two 1,500-kilowatt alternating-current generators, supplying current at 2,300 volts. The current at this pressure will be carried to the transformer houses, where it will be raised to 33,000 volts for transmission. A transmission line of about twenty miles will be constructed at present.